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An immense mahogany tree growing in the forests of Trinidad

THE MAHOGANY TREE—[See page 136]

Some Present-Day Techno-Chemical Problems*

Illustration of the Opportunities for Applying Scientific Knowledge to Industries

By Dr. Raymond F. Bacon,† Director of the Mellon Institute of Industrial Research, University of Pittsburgh

THEODORE N. VAIL, the distinguished organizer of the greatest telephone system in the world, has well expressed a recent industrial recognition:

> "Research, investigation, experiment, comprehensive and thorough, are now necessary to hold any position in any industrial or utility enterprise."

Mr. Vail attributes the success of his company—the the nervous sytem of our economic and social structure—to the centralized, coördinated work of operation with research. Transportation, the circulatory system of the world, owes a similar debt to scientific investigation, for its development has resulted entirely from industrial growth, for which chemical inquiry is so largely responsible. It is now generally conceded that research and progress are synonymous as applied to manufacturing.[1]

The recent impetus imparted to the investigational activity in American chemical manufacturing has materially altered the traditional policy of industrial secrecy.[2] This change in attitude, the direct product of the appreciation of urgent action in industrial research has been long desired by our universities, and it will undoubtedly result in the extension of the practice of referring certain of the problems of industry to university laboratories for study. Many of the numerous problems of chemical manufacturing could be advantageously attacked outside of the plants; but some central organization, similar to the Committee on Research in Educational Institutions of the National Research Council, is needed for securing and properly distributing those problems which are pressing. It is clear, however, that stable relations between the universities and industrialists will be worth while only if some mutual benefits can accure therefrom. This coöperation can therefore be most satisfactorily promoted by actively demonstrating the advantages of the exchange or interchange of subject for research, which primarily presupposes a reasonable freedom from the concealment of knowledge which tenaciously adheres to all industrial research.

I shall now pass rapidly over some of the announceable problems of manufacture,[3] for the most part in the traditional industries—problems that a few years ago were either not given any consideration or were unknown, but which are now the subjects of considerable contemporary inquiry and even anxiety.

SOME PRESENT-DAY METALLURGICAL PROBLEMS

A metallurgical problem which invites the investment of research with peculiar force, is the concentration of the so-called brown-ore of Virginia, Tennessee, Kentucky, Georgia, Alabama, and Texas. Calcined brown-ore, carrying more than 50 per cent of iron is readily marketable and it is said that processes of the type of the Goltra method may be profitably applied not only to these deposits but also to brown-ore "banks" which cannot be worked by old methods of preparation. Other iron-ore problems are the economic utilization of the aluminous ores of Tennessee and of the siliceous potash-bearing ores (gray iron ores) which occur in other southern states.

In blast-furnace practice there is needed some method increasing the basicity of the slag without increasing its temperature; very little information is available regarding the amount of sulphur which can be expelled with the top gases; the control of manganese is comparatively incomplete; little is known of the general subject of the effects of variations in the carbon contents of the different kinds of iron and consequently we are unacquainted in detail with methods for the systematic control of carbon; and there is a lack of experimental knowledge relating to the action of a considerable percentage of vanadium in the blast-furnace charge. Reference may also be made here to the problem presented to the production of ferro-vanadium alloys directly from iron ores containing vanadium; this is difficult because vanadium goes into slag very readily.

The following are some of the many other problems in siderurgy: the recovery of manganese as an alloy from slags high in manganese; the extension of the commercial uses of open-hearth and converter slags, particularly a broad study of their use in ceramics; the improvement of the quality of cast-iron or pig iron of ordinary coke grade, to make it the equal of higher-priced charcoal iron; the influence of beta-iron on the hardening of steel; the relative merits, as regards corrosion, of various iron products, and especially pure iron as compared with ordinary open-hearth and copper bearing steels;[4] the cause of internal transverse defects in rails; satisfactory substitutes for imported magnesite as an iron and steel refractory (zirconia is too costly)—this problem actually resolves itself into how to use domestic magnesite—and for graphite as a foundry facing; the cause of the lack of success in the use of ferro-silicon to replace entirely the ferro-manganese in the deoxidation of steel; and the possibility of recovering by-products from blast-furnace gases, such as compounds from which cyanides might be made.

Mention has been made in several other communications[5] of certain of the problems encountered in the metallurgy of zinc. The treatment of flotation concentrate is one of the present troubles of the zinc smelter, owing to its great fineness. While the proportion of this grade of ore which the smelter is obtaining is still small the supply of it is, however, certain to increase. The roasting of ferruginous blends in such a manner as to convert all of the zinc into sulphate and oxide, avoiding the formation of sulphite and ferrite, is another interesting subject for research. Two other problems in this field are the manufacture of retorts of higher tensile strength and greater durability, and the relation of the elements of the ash ingredients of the reduction fuel to the same elements in the ore, having in mind a more satisfactory blending of the ore and the reduction material.

The increasing adaptation of flotation to the treatment of low-grade copper ores has somewhat discouraged the use of leaching methods and accordingly these processes have not made the progress expected; but the field is still open for oxidized ore where flotation has not thus far been successfully applicable. Successful flotation assumes that the copper content of the ore is in the form of disseminated mineral. In the case of ores wherein the copper compound is diffused throughout a mass of gangue, such as is undoubtedly true of the copper silicate ores found at Inspiration, it is certain that flotation is out of the question and that some leaching process must be used.

The acidity of the gases from copper and lead smelting works presents a problem which still awaits solution. In electrical precipitation, the treatment of enormous volumes of gases in the smelter flues introduces several problems: in addition to the magnitude thereof, there are the problems connected with the handling of the fumes and dust and their metallurgical treatment. It is, of course, possible at present to separate from certain fumes, thousands of tons of arsenic annually and it would probably be feasible to separate an amount of sulphur which would run into hundreds of thousands of tons annually, were there markets for such quantities of these by-products. The problem therefore, resolves itself into the establishment of new tonnage uses for arsenic and sulphur.

In the metallurgy of the precious metals, the high price of zinc has stimulated renewed study of electrolytic methods of precipitating (the new plant at Great Falls, Mont., is illustrative of the trend in this direction), and a large amount of experimental work is in progress on the application of the flotation process. In the case of concentrate produced by flotation, the minerals composing the product are substantially the same as those obtained by gravity concentration, consisting of the sulphides and the double sulphide of the heavy metals, and therefore similar difficulties are encountered in their treatment.

Other more familiar metallurgical problems are the prevention of zinc loss in the brass industry, the elimination of arsenic from antimony, and the cheap deoxidation (retrieving), of aluminum remelted from scrap; but after all, the conservation of our metals and their protection after they have been manufactured and put into service, holds out most interest.

Among the less used metals, the alkaline earth elements are begging utility. There is no doubt that calcium could be produced economically even by methods now known if it were manufactured on a large scale to fill an extensive demand, but markets therefor must first be established by the discovery of important new uses. Results of commercial significance might be obtained by the investigation of the alloys of calcium and of its application as a chemical purifying agent in melting and casting metals. Calcium has been used in Germany as a substitute for ferro-manganese in the deoxidation of steel. In the cases of barium and strontium, uses could be developed if methods were known by which these metals could be isolated cheaply; while with magnesium an electrolytic method is required which will enable its production for about 25 cents per pound (direct reduction of the oxide, like alumina, is suggestive). Beryllium is another metal whose properties should receive broad investigation, for at present its known uses do not justify its cost.

The production of boron and ferro-boron of uniform quality requires expert study. Cheap and pure chromium is now obtainable; the electrolysis of its fused salts is is difficult on account of their high melting-points, but perhaps the electrolysis of water solutions of chromium salts could be so controlled that heavy deposits would be produced. Then, too, chromium electroplating is for many purposes superior to nickel, but the technique of constantly producing perfect plating has not been accomplished.

Since there is no lack of raw materials, broad study should be made of the methods for producing pure titanium and zirconium and of their prospective uses. The same statement also applies to molybdenum, although the greatest need of the molybdenum industry at the present time is a more economic utilization of its sources of raw material: in general, the deposits have been neither properly prospected nor opened up, and then not wisely worked; and loss and waste should be minimized as the result of a careful investigation of crushing and concentrating methods. However, the relatively small tonnage of molybdenum needed at present is a handicap in the exploitation of its ore deposits.

OTHER PROBLEMS OF INDUSTRIAL INORGANIC CHEMISTRY

There is real need of extensive experimental research on the chemical character of coal. The knowledge regarding the combustion and distillation of coal is principally empirical, and will of course remain so until a clearer insight is had of the actual nature of the complex compounds contained in the coal substance and of the mechanism of their decomposition by heat. Two very important problems in the preparation of coal for the market have to do with "waste": the production of an absolutely smokeless fuel in the manufacture of briquets from anthracite culm; and the utilization of the high-ash (60-75 per cent), high-sulphur (5-10 per cent) waste from bituminous coal washers.

Many other problems exist in the domain of mineral technology. New uses are desired for tripoli; the Gypsum Industries Association is engaged in furthering the development and advancement of the uses of gypsum; and the employment of slate in the manufacture of blackboards and school "slates" has so decreased that new applications are wanted to replace this loss of market. Then there are the problems in connection with the use of the natural abrasives, emery and corundum; one still hears of the sudden and wide variation in the composition of different shipments; but since the development of high-grade artificial abrasives and the exploitation of larger corundum deposits in Ontario, no corundum has been produced and only a small quantity of emery has been mined in the United States, and accordingly

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*An address delivered before the New York Section of the Society of Chemical Industry on November 24th, 1916.

†On May 14th, 1915, I addressed the Chicago Section of the American Chemical Society on "Some Problems of Chemical Industry," and the discourse was duly published, in condensed form, in J. Ind. Eng. Chem., 7 (1915), 535. However, a number of omissions occurred in that brief report, and, at the request of my colleagues, I have endeavored to supply, principally for the research workers in our universities, the additions necessitated for completion of the presentment. The present contribution is, therefore, supplemental to the paper cited.

[1] On this relation, see Bacon, SCI. AM. SUPPL., *1915*. No. 2081, 334.

[2] For an illustration, see the reports of the Industrial Conferences at the 53d Meeting of the American Chemical Society (J. Ind. Eng. Chem., *8* (1916). 947 *et seq.*).

[3] In colating these I have drawn from all available sources of information and especially from my experience at the Mellon Institute.

[4] Because of the immense amount of research which has been carried out on this subject, I have hesitated in citing the above-mentioned problem as unsolved. However, the fact that controversy still prevails places it in that class. Personally, I believe that the advocates of the use of copper-bearing steels have much the best of the argument.

[5] See Bacon, Science, N. S., *40* (1914) 877; and J Ind. Eng. Chem., *7* (1915), 535.

new uses are being sought for these minerals. The abrasive garnet market is also strictly limited and shows little tendency to extension at present. Reference may be made here to several problems in the technology of Fuller's earth, the literature of which is meager and unsatisfactory. Little is known regarding the qualities of a Fuller's earth which adapt it to its applications; there is a needless obscurity concerning the changes which it occasions in oils and to which it is itself liable; it is not clear why certain earths possess a tendency to cause spontaneous combustion in the material from the filter presses; and, finally, what is the cause of the malodor which sometimes accompanies the use of a particular earth?

The problem of commercially separating a soluble potassium salt from brine containing NaCl, Na_2CO_4, and other salines remains unsolved; the cleaning and drying of phosphate rock should be done more economically; and the regenerative system of heating has not been profitably applied to the pottery industry. In fact, an attractive variety of problems is found in all sections of the inorganic field, and many—particularly a compact apparatus for generating hydrogen which could be erected on a freight car and easily conveyed about for Governmental purposes; the economic production of nitric acid from ammonia by the catalytic process; the development of a commercial process for manufacturing aluminum nitride; and the direct preparation of hydrated sodium carbonate in a stable powdered form and of sodium silicate in a readily powdered solid soluble form—might be attacked to advantage without the purlieus of industry.

However, of all the anxious inquiries coming in from our manufacturers, those pertaining to refractories possibly possess the most notable academic interest[6]. What is the exact location of the inversion point of the crystalline form of calcium oxide? Why is the porous of calcium oxide so much more reactive than the crystalline? What are the physico-chemical properties of ferrous oxide at high temperatures? What are the relations of the inversion points of the iron oxides to one another? Can alumina be satisfactorily made (sintered) into a dense hard refractory without the aid of a bond, thus obviating the troublesome shrinkage which occurs at temperatires far below the melting point of alumina? And finally there are the troubles in the case of refractories for open-hearth furnaces. The principal source of difficulty is the slagging tendency of the dust, which is derived partly from the producers and partly from the charges. Perhaps a satisfactory means of suppressing the dust might be devised, but another possible way out of the trouble might consist in replacing the acid bricks of the checkerwork by basic ones. Magnesia and bauxite bricks have been tried, but are liable to shrink; this weakness might be overcome in the case of the bauxite bricks by burning at a sufficiently high temperature and by suitably modifying the texture and composition.

In fact, it sometimes seems to me that the greatest single problem in chemical technology is the one of refractories. There are many industrial problems that now appear to be impossible of commercial solution which could be immediately solved, provided we had some ideal refractory substance which would retain its shape and strength at high temperatures and would not be acted upon by the acid or alkaline constituents of a charge or by the gases evolved during the reaction.

PROBLEMS OF INDUSTRIAL ORGANIC CHEMISTRY

The inquiries which come from the domain of organic technology are well illustrative of the opportunities which exist for coöperative research as well as explanatory of the existing anxiety for new ideas in manufacturing. More numerous, perhaps, than any others are queries regarding coal products and their manufacture.

In particular, the problems in connection with the by-product coking of coal are of especial importance at the present time. It is generally conceded that "coke breeze" is not being utilized in the most economical manner; new uses should be found for pitch and coumarone resin; the acid tar from the chemical treatment of light oil should be recovered and worked-up; and, for availability in times of peace, there should be accumulated a reserve of knowledge on new uses for benzene and toluene.

The related tar distillation industry presents the following problems[6]: What is the cause of corrosion in tar stills? Is the present method of separating fractions the best in view of the products required? Uses are also wanted for creosote oil and for lesser known bodies in the distillates; there is required a broad investigation of coal gas pitch to discover ways for rendering it more suitable for replacing natural asphalts; and the methods of testing coal tar products should be standardized. Two questions which have arisen in the manufacture of coal gas are worthy of mention in this place; these are: Have we exhausted the chemical possibilities of by-product or retort coal gas when we have recovered from it the ammonia it contains; and is it feasible to make gasoline from coal gas? This last problem does not appear to me to be commercially practicable in America, but it is under consideration in England and other countries which produce no petroleum.

The numerous problems of the petroleum industry have been considered at length elsewhere[7], but reference may be made here to several problems of the Scottish shale oil industry. Much remains to be learned regarding the best conditions for the production of crude shale oil, in particular the form of retort and the temperature of working; eighty to eighty-five per cent of the raw shale put into the retort is sent to the waste heaps as spent shale, the utilization of which has not been the subject of sufficiently extensive research; and the refinery tars, now used as fuel, should be investigated with the object of separating commercially valuable substances. These problems are of more than mere passing interest to American chemists on account of the probable early development of certain of our large domestic oil-shale deposits.

The problems of technical phytochemistry are of considerable economic importance. Many of our plants are wasted either because of a lack of knowledge regarding their possibilities or because of a deficiency of interest in their industrial development. The processes for obtaining rubber from guayule sap are unperfected; the method employed for extracting wax from candelilla is crude; algerita and osage orange contain dyestuffs, but have received practically no attention; the commercial possibilities of mesquite seed and wax are unknown, and the same statement applies to the wax or gum from prickly pear cactus; no suitable process is known for degumming ramie fiber and making it spinnable; there is no knowledge of the industrial possibilities of bear grass; the use of rice straw and cotton stalks as paper-making materials requires more study; and the castor bean, sunflower and camphor tree are well adapted to the coastal plain of Texas and should constitute the bases of well-established industries.

The cotton industry holds out engaging opportunities for chemical research. The following are some of the problems which confront the planter of cotton: What is the action of various fertilizers on the yield of cotton and on the quality of the fiber produced? Are there available any fertilizers which can be substituted for potash, and, if so, what conditions must be observed in their application to the soil? Can a chemical treatment be devised for destroying the Mexican boll weevil, or at least rendering it harmless? And then there are the problems in preventing the production of stained cotton during seasons of excessive rain and in bleaching stained cotton a pure white.

The chemist has been of inestimable value to the wood turpentine industry. In addition to developing processes and designing suitable plants, he has standardized the products, created markets therefor, and found uses for the important by-product, pine oil. However, there are still opportunities for other chemical contributions. Fresh crude turpentine contains normally about thirty per cent of spirits of turpentine, but under the most improved methods of collection and distillation in use at present, yields of only eighteen to twenty per cent are obtained; this loss of at least one-third of the volatile oil remains to be overcome. The French method of bleaching rosin is slow and otherwise uneconomic, but the chemical methods which have been proposed are unsatisfactory; methods of distillation by the use of superheated steam or vacuum, although apparently desirable, have so far had no altering influence on methods of manufacture; and the disadvantages of wood fiber from turpentine production as a source of pulp remain to be overcome. Notwithstanding its charcoal and bark contents, this fiber is said to produce a satisfactory grade of brown wrapping paper, and there is now some activity in this utilization. The question of substitutes for wood in the manufacture of paper pulp is a pressing one, and any source of relief is gratifying. Perhaps the manufacture of tannic acid extract from palmetto roots and other sources might be made profitable by the production of paper pulp from the fiber residue.

Other problems in the organic branch of chemical industry are the production of a satisfactory butter-substitute from soy-bean oil, the cheap extraction of vitamines from rice hulls and from yeast, the recovery of the wax occurring on the outer surface of the sugar-cane, and the economic production of ammonia from sources in the various stages of beet-sugar manufacture.

The many opportunities that lie everywhere at hand in this entire field and particularly in pharmaceutical chemistry make one frankly consider why expert organic chemists should devote laborious days to preparing some substance of purely academic interest, while there is urgent need for practical working processes for the synthesis of atropine, cocaine, morphine, and quinine. One is reminded of Chesterfield's remark that, "Very few people are good economists of their fortune, and still fewer of their time." when this mismanagement of laboratory resources is further evidenced by citation of the following instances of desired commercial synthesis; formaldehyde, acetic acid, amyl alcohol, tartaric and citric acid, ssanguinarine, hydrastine, caffeine, and notincie.

A favorable occasion for industrial service also exists for the physical chemists of our universities. To mention one illustration from the field of organic chemistry, but little progress has been made on the employment of light in the manufacture of such chemicals as the chlorides of carbon, although photochemistry has developed into an important theoretical branch. Light is a powerful, uncontaminating catalyst for effecting certain chemical reactions, and the white flame arc has opened up many possibilities for controlling and altering oxidation and halogenation processes.

The problems listed above represent only a fraction of those which might be disclosed, but they are illustrative of the opportunities for applying scientific knowledge and investigational methods to the domain of industry. On every side the research men of our universities are needed for the execution of real attainment in the technical world, with its difficulties, wastes and unexplored lines of manufacturing.

Sentencing the Hawks

AMONG American ornithologists and bird lovers in general, there is much discussion as to the proper attitude that should be assumed toward the Cooper and sharp-shinned hawks. These avian scourges feed almost entirely on small birds. This fact has prompted many persons to denounce their crimes and demand their extermination, and influenced others to defend them on the basis that by killing off the surplus they help to maintain a proper balance in nature.

While we agree with the sentiment that no form of life should be completely exhausted, we do not believe in the existence of such a surplus of songbirds that it should require removal. Before the advent of man, the depredations of the natural enemies of bird life were of little consequence. Now, however, when the conditions are so adverse to their rapid increase that it has become necessary to exert every effort to aid them, we think that bird-killing hawks have outlived their usefulness. Sharp-shinned and Cooper hawks are very abundant in the vicinity of the Zoological Park, and hardly a day passes that does not bring some evidence of their rapacity.

A younger Cooper hawk was presented recently to the Park, and accompanying the bird was an illuminating letter from the donor, Mr. J. F. Paull, of Wheeling, West Virginia. Having secured the young bird, Mr. Paull states that he placed it in a cage near the nest. "The first day, the old birds brought a young chicken, a mouse, a catbird, a sparrow and a meadow lark, possibly more, which they ate". . . . "The other hawk the next day brought another young chicken, a flicker and a ground squirrel." Needless to say, the efforts of these particular birds to remove the surplus have been discouraged.—*Bulletin of the New York Zoological Society.*

Red Squirrels

IN the early history of the Park, we determined to exterimate the red squirrel within our bounderies, owing to that animal's deadly persistence in robbing birds' nests. The red squirrel disappeared for a number of years, and we cultivated the Carolina gray squirrel, which, owing to its docile and confiding nature, delights our younger visitors. Various clans of these gray squirrels, and members of the black phase as well, inhabit different parts of the Park. They pry into visitors' pockets, feed from the hand and are in every way likable and attractive.

Of late we have again heard the chatter of the mischievous red squirrel in the Park, and several of the keepers investigated. They discovered an interesting condition. Ordinarily, this species is excessively wary, but led on by the boldness of the gray species, the few red squirrels that have wandered in are also soliciting dainties from visitors. One specimen found by Keeper Lansberg is so confiding it may be picked up in one's hand and stroked like a kitten—an extreme type of confidence that quite surpasses that of the wild gray squirrel. We have found two red squirrels like this, and while we have forbidden them the free run of the Park, they are happy in large cages of the Small Mammal House. When the men are cleaning their cages, these squirrels run about over their shoulders, making no attempt to escape.—*Bulletin of the New York Zoological Society.*.

[6] On other problems of the coal-tar industry, see Bacon, J. Ind. Eng. Chem., 7 (1915), 535.

[7] Bacon and Hamor's "American Petroleum Industry," 1916, 2, 798-807.

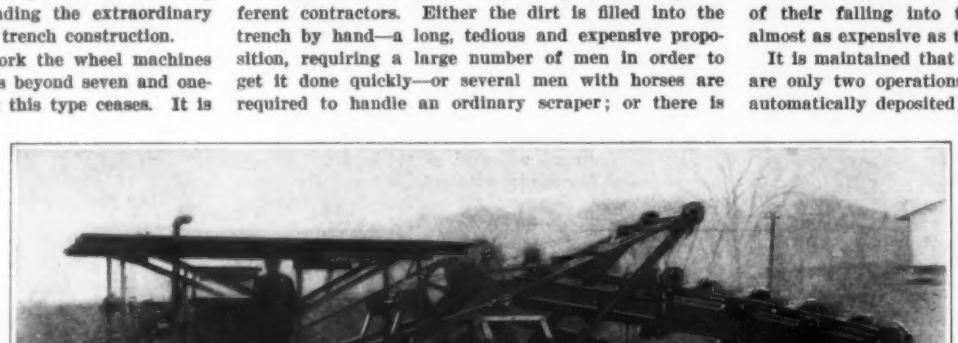
Trenching by Machinery

Power Devices that Facilitate the Work of the Contractor

By Frank C. Perkins

THE accompanying illustrations show a novel gasoline ladder excavator which has proven extremely successful in meeting the requirements of a wide class of work, and has stood up under the most severe conditions. The contractor who has made a thorough study of modern methods has come to realize that he must meet his competitor on even ground—that is, by means of proper machinery. It is clear that such machinery must have efficient motive power, and must be long lived and capable of withstanding the extraordinary shocks so often encountered in trench construction.

Although for all ordinary work the wheel machines are more economical, for depths beyond seven and one-half feet the economy of using this type ceases. It is pointed out that the enormous size of the digging wheel, and the necessity for a heavier and stiffer frame and the bigger engine required, tend to increase the weight and cost of such a machine far beyond economical limits. In other words, the cost and weight of such a machine is out of all proportion to the work required. In order to meet the demands of deep trench digging, therefore, it becomes necessary to use the ladder type machine. It is clear that the transmission of power on the "all-steel" machine is by means of gears and chains, and a friction clutch is provided to relieve the machinery should a solid obstruction be encountered.



An automobile ladder type excavator with a corduroy grip tractor

The "corduroy grip" tractions are provided for supporting the rear or heavy end of the machine. They are driven by means of chains through differential on the main propelling shaft and are provided with brakes to enable the machine to turn sharp corners. The main frames of the tractions are built up of structural material and are pivoted on a heavy shaft supported in bearings on the under side of the car body. This enables the tractions to accommodate themselves independently to inequalities in the ground and relieves the main framework supporting the machinery of all twisting strains.

The traction chains are made up of cast steel links with manganese steel bushings and pins, insuring long life to the parts. The supporting blocks are of hardwood, fitted on their upper surface into sections of steel channel and shod on their lower or bearing surface with steel plates. The pressure between the supporting blocks and supporting frame is taken up by a series of chilled iron rollers of large diameter. The digging boom of the machine is rigidly mounted on fixed pivots, carried on very strong and heavy structural supports, directly above the corduroy grip tractions. The load is therefore carried in the most advantageous position.

The hoisting is done by means of a worm wheel and gear, friction operated. The lowering is done by means of a friction brake. This system provides a very simple and effective method of handling the digging apparatus. The bucket chains are of steel, with manganese steel pins and bushings.

The buckets are cast steel, with tool steel teeth. They are attached to the chains by pins and may easily be removed. Wider buckets or longer digging teeth are substituted if wider trenches are to be dug. By means of a positive cleaner, which can be easily applied when necessary, each bucket is scraped clean at the time it dumps, thus insuring clean buckets all the time. The boom is of the box girder type and this is much stronger than the open or lattice type, while extensions for deeper trenches may be added, which, of course, are designed to work within the power capacity of the machine. The dirt may be deposited on either side of the trench by shifting the conveyor. This is easily done without dismantling the machine.

Another illustration shows a power back filler, which is utilized in perhaps the most troublesome and expensive operations that confront contractors on sewer, water, gas or other trench work. It is said that the cost of backfilling alone equals the cost of the excavating itself. Usually the dirt in the spoil bank has settled to such an extent that it requires almost the same effort to move it as it did to take it from the trench.

There are three methods ordinarily followed by different contractors. Either the dirt is filled into the trench by hand—a long, tedious and expensive proposition, requiring a large number of men in order to get it done quickly—or several men with horses are required to handle an ordinary scraper; or there is the power drag line method as shown in our cut.

The trench digging machine in operation

A clean sweep with a one man back-filler

The hand process needs no particular comment. The use of a team is expensive because about three fourths of the time is wasted in turning the horses. This must be done twice, after dumping the load and just before taking a new one. In addition, the greatest delays with this method are caused by the horses becoming unhitched or entangled in the harness. These items, with the strain on the horses and the constant danger of their falling into the trench, make this method almost as expensive as the hand way.

It is maintained that with the power backfiller there are only two operations, dragging the load (which is automatically deposited) and bringing the bucket back to position. The regular speed, when the boom is extended to its full length of twenty-five feet, is four loads a minute; and the loads are from three to four times as big as the ordinary scraper loads. When the boom is shortened the speed is increased considerably. It takes a team and two men from one to one and a half minutes to complete one cycle, so that the machine can do from twelve to sixteen times the work of the horse outfit, or replace from fifty to 100 men. The trench is filled uniformly quickly, and the road is cleaned up perfectly at one operation. The entire work is done by one operator, without help of any kind.

Plants and Asphyxiating Gases

THE deleterious gases used in the war not only have the bad effect upon human beings with which we are familiar, but they have such a corrosive nature as to even attack plants, as is now attested by several observers. Different plants are variously affected by the gases, as might be expected. The following are some of the first observations which we have to record: In the Champagne region, certain varieties of pine trees were burned or reddened, but not the epicea or the juniper. At Bailleul, situated some five miles from the fighting line, the hothouses belonging to M. Cordonnier suffered not a little from the effects of such gases during the month of April, and this was specially noticed in the case of grape vines, which were already in a fair stage of growth. Here the leaves were not reddened but were covered with white or discolored spots, and afterwards they turned brown and fell off. According to the experiments made by M. Viala, chlorine water gives the same results. In hothouses of the closed type the bad effects were very slight on account of the dryness of the air, but in growing houses of the cold air type they were much more noticeable. Other observers noticed a more or less marked effect of the gases upon growing grain, and especially rye. It is considered that the stage of growth as well as the moisture of the air have a certain influence upon the character of these phenomena.

Air Temperature in the Tropics

AN investigation of the upper atmosphere conducted at Batavia by means of small baloons carrying self-registering instruments has given interesting results. At sea-level the mean temperature is 26 deg. Cent. Temperatures of 0 deg. Cent. were registered at a height of 4.7 kilometers. At 10 kilometers the temperature was —34 deg. Cent., and at 17 kilometers —84 deg. Cent. In England at 10 kilometers the temperature is —51 deg., and at 17 kilometers it is —54 deg. The existence of very low temperatures at great heights in equatorial regions may now be regarded as certain.—*The English Mechanic.*

Tenacity to Life in Insects

By Robert Cunningham Miller

THE unusual success of insects in the struggle for existence has been a subject of much discussion in scientific circles. Just why it is that these little creatures have survived the ravages of birds and other enemies, as well as the ingenious contrivances of man for their destruction, and form to-day the most numerous class of animals on the face of the earth, leaves a wide field for argument and conjecture. Two important reasons for this have been pointed out by naturalists, i. e., their prolificacy and their extraordinary adaptation to environment. Another just as potent reason, which has received less attention, is their amazing tenacity to life, many species being able to survive injuries which would cause almost instantaneous death in the higher forms of animal life.

The writer's attention was first particularly directed to this fact by observing the vitality of a moth, and this led to a further study of the same phenomena in other insects. The moth in question was caught by one of my assistants and, after being chloroformed in the usual manner, was brought to me. In order to make death doubly sure, I plunged a red-hot needle through its thorax and afterward mounted it upon the setting board. One evening, four days later, I looked at it again. It appeared quite stiff and dead, and I thought that it would soon be ready for the cabinet. Imagine my surprise the following morning to find that it had laid several dozen eggs during the night!

About the same time a similar thing happened with another moth of a related species. As the specimen appeared quite dead, I stretched it out upon the setting board and placed it away to dry. A few nights later I was awakened by a violent fluttering on the table where specimens were prepared for mounting, and, upon examination, found that the moth had revived, worked the pin loose from the board in its struggles, and beaten its wings to pieces in fluttering about.

Spiders also share this unusual vitality. I have in my collection a large trap-door spider who appeared as lively as ever for some days after being chloroformed twice and pinned through the cephalothorax.

Certain species of Coleoptera, such as the sacred beetle (*Ateuchus sacer*), are almost impervious to the effect of chloroform, and must be subjected to its fumes for several hours to insure death.

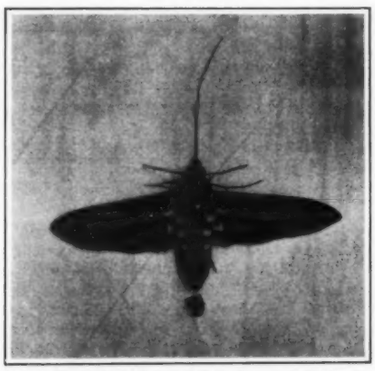
Some aquatic species of Hemiptera, particularly members of the family Belostomidae, can perform the ordinary functions of swimming and crawling for some time (occasionally several hours) after the head has been severed from the body. In this case, however, the motion is probably merely reflex nervous action, rather than an indication of conscious existence.

These examples certainly tend to prove that insects are liable to survive all ordinary accidents which are likely to befall them, and thus have a great advantage over the members of the animal kingdom which are more advanced in the scale of life. Entomologists know that it is quite common to find imperfect specimens of insects. In fact, it is almost the exception to find perfect specimens of certain kinds of warlike beetles and delicate-winged moths. Numerous tiger beetles are found with an elytron or two or three legs missing. Maimed crickets, the battered heroes of many a battle royal, are often caught in the collector's net. Bugs and beetles frequently escape from birds with the loss of several important appendages, and still live to destroy our trees and gardens.

After considering a few facts like these we cease to wonder that creatures which can live just as comfortably with one wing as two, with three legs as six, and even lay eggs after living five days upon a pin, have been the most successful in the struggle for existence and have come to surpass in numbers all other animals of the earth.

Physiological and Pharmacological Studies on Coal Tar Colors

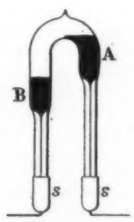
THE action of the following dyes was investigated: Benzeneazo-^{1}-naphthylamine (Yellow AB), tolueneazo-β-naphthylamine (Yellow OB), benzeneazobenzeneazo-β-naphthol (Sudan III), benzeneazo-β-naphthol (Sudan I)-, benzeneazodimethylaniline (Butter Yellow), benzeneazophenol (Oil Yellow), benzeneazoresorcinol (Sudan G), and aminoazobenzene (Spirit Yellow); these were administered subcutaneously, intraperitoneally, intravenously, and by mouth to rabbits, and, in a few cases, to cats and rats. The effect of renal disturbance on the elimination of the dyes was determined by the administration of zinc malate and of chenopodium oil. It was found that the dyes were eliminated in the urine and in the bile, but that the elimination in the urine was usually inhibited in poisoning with zinc or chenopodium oil. The greater part of the dyes was deposited in the adipose tissues; staining of the nervous tissue, the kidney, and muscle was also noticed in some of the experiments. Dye was still present in the blood 15 hours after the intravenous injection of 25 milograms of benzeneazoresorcinol per kilogram of animal. Two of the compounds of benzeneazophenol and benzeneazorescorcinol, which were isolated from the urine of rabbits, proved to be conjugated with glucuronic acid. The toxicity of the various dyes was not pronounced even when large doses were administered.—*Note in Journal Society of Chemical Industry from a paper by W. Salant and R. Bengis in the Journal Biological Chemistry.*



A moth that laid eggs five days after being chloroformed and pinned to the setting board

A Cadmium Vapor Lamp

IN a recent issue of the *Electrician* is described a novel cadmium vapor lamp. It consists of a quartz tube, *AB*, shaped like an inverted U, terminating at each end in a thick walled capillary tube attached to a tungsten electrode, *S*. The chamber *AB* of the tube forms two unequal compartments, the smaller, *A*, connecting with the cathode, and the larger, *B*, with the anode. These contain a certain amount of cadmium, sucked in in a liquid state through the capillary tubes in order to free it from every trace of oxide or other solid matters which would make it adhere to the glass and crack the latter.



To put the lamp in service it is necessary to heat the tube over a Bunsen burner until the liquid metal is volatilized and an electric arc set up in the vapor formed.

The lamp is attached to a circuit of 100 or 200 volts in series with a resistance calculated to give a current of 5 to 7 amperes. The tension at the poles is about 30 volts.

Tone Reproduction in Photography and Its Limitations

THE possibility of obtaining a correct continuous tone reproduction, *i. e.*, one in which the tone values bear the same relationship as in the original, is dependent upon the luminosity range of the object, the qualities of the plate used for taking the negative, and the quality of the printing medium. The total range of most subjects is less than thirty to one and this range is easily obtained on the "correct exposure" portion of a good negative plate. The total range of photographic papers, including the "under-" and "over-exposure" periods, varies from about sixteen to one with matt surface development papers up to fifty to one with glossy development papers, and reaches as high as two hundred to one with glossy P. O. P. The curves of a number of papers obtained by plotting logarithms of exposures against reflection-densities, are given. A special instrument was designed for measuring reflection densities, the paper surface being illuminated at 45 degrees and viewed at 90 degrees to avoid the interference of specular reflection. Curves are given illustrating the results obtained by reproducing through a given plate on to a given paper. It is easily seen that scientifically correct reproduction is not obtainable except for a very limited range and using only the middle tones of both plate and paper. The problem as to whether scientifically correct reproduction is also artistically correct is then considered. Numerous facts are collated dealing with the sensitiveness of the eye under different conditions to lights of varying luminosity. The normal eye sees correctly over a range of about twenty to one in bright diffused daylight and approximately correctly over a range of about one hundred to one. Outside these limits—from ten thousand to one million foot-candles luminosity—departures from correct seeing are increasingly greater, a given range of luminosities appearing less than it is. The exact relationship which should exist therefore between the range of luminosities in the original and the range of tones in the reproduction is dependent upon the actual values of the former and also to some extent on the conditions under which the reproduction is to be viewed. The varying qualities of plates and papers give the photographer a certain control over this relationship which would be absent if the "correct-exposure" portion were the whole of the characteristic curve.—*Note in the Journal of the Society of Chemical Industry from a lecture by F. F. Renwick in Phot. Jour.*

Antagonistic Action of Salts in Plants

IN the author's experiments natural conditions were attained by growing the plants (maize) in earth contained in pots with perforated bottoms through which the roots passed into the prepared solutions below. Under these conditions solutions of the chlorides of sodium, potassium, and magnesium and magnesium sulphate, above certain concentrations, were strongly poisonous, calcium chloride to a much less extent. Even with concentrations of 3-25M the toxic action of sodium and potassium chlorides was annulled by the addition of only 10 c.c. of calcium chloride solution (3-25M) to 1138 c.c. of their solutions; the magnesium solutions required considerably more. The antagonism found by Osterhout between sodium and potassium chlorides, and between sodium chloride and magnesium sulphate was not confirmed with certainty, and in any case it is very small compared with that of calcium chloride. The calcium salts have a special function which can be undertaken by no other salt. The work of other investigators on this point, in particular that of Loew and Hansteen, is discussed. The contradictions there found may be explained on the ground that these authors drew their conclusions from quite different plant types, and it is not permissible to generalize on results obtained from one species any more than to assume any parallelism in the antagonistic salt action in plants and animals. A feature common to all antagonistic action, however, is that it is a colloidal reaction, and the calcium ion undoubtedly has a special function in this respect, both in the animal and vegetable kingdoms. In practical agricultural investigations, when the plants are growing in the natural soil, great difficulties, underestimated by Loew and his collaborators, are experienced, particularly since sufficient knowledge is lacking of the way in which the roots exert their functions.—*Note in Journal Society of Chemical Industry on a paper by J. G. Maschhaupt in Verslag, Landbouwkund, onderzoek.*

Cork Fabric for Featherweight Raincoats

CORK fabric is a recent French production, the result of a new French process. It is waterproof, a non-conductor of heat, and unbreakable. By using a special machine, thin slices of cork of an even thickness are obtained from a block of cork. The slices are placed in chemical baths in order to remove the resinous parts, which make cork a more or less brittle substance. Upon their removal the cork sheets become flexible, and may be compared in this respect with thin leather. In fact, the sheets can be folded and bent without breaking. By combining the cork sheets with any suitable cloth, preferably a thin and strong cloth of good color, an excellent waterproof material is obtained. An adhesive preparation is employed to glue the cork to the cloth; or, if a stronger garment is desired, the cork sheets are placed between two layers of cloth.

A Gas Pressure Reducer

IT often happens that the gas supply in the mains is at a too high pressure to be used with economy in gas stoves, and in any case there is danger of using considerably more gas than is really needed, so that a device for reducing the pressure will prevent waste of gas in quite a number of cases. A simple device of this kind has one end connected by hose to the mains, while the gas comes out of the other end and goes by a second hose to the burner. Between the high and the low pressure sides is placed a partition containing a set of fine holes, so that the gas can only pass through at a reduced rate, and this is found to lower the pressure very effectively.

Seaweeds*

Some of Their Economic Uses and Possibilities

By Dr. Marshall A. Howe, Curator of Flowerless Plants, N. Y. Botanical Gardens

THE seaweeds, or marine algæ, as most of them are known to botanists, are more or less abundant in many parts of the world, but it is chiefly along rocky coasts of the temperate regions of both the northern and the southern hemispheres that they are sufficiently large and numerous to attract general attention. And it is only in such regions that they have been and are likely to be of some economic importance. In the vicinity of New York City the seaweeds are, as a rule, not particularly large or abundant, yet there are places, as at Pelham Bay and Hunter's Island, where the rocks and stones along the shore are left by the ebbing tide more or less densely covered with a coating of conspicuous algæ belonging to the group commonly known as the rockweeds. Most of the sea plants grow either between the tide-lines or in water that is comparatively shallow, few of them being found attached to the bottom in water that is more than two hundred feet deep. As one goes northward along our Atlantic coast from New York, the seaweeds become more conspicuous and abundant, this abundance being especially pronounced in northern Massachusetts, the coast of Maine, the southern coasts of New Brunswick and Nova Scotia, and certain parts of Newfoundland. It is not everywhere along the seashore even in those regions that the algæ occur in any obvious quantity. They are usually wanting on a loose sandy or muddy bottom, principally because they find little anchorage or foothold in such places. And there are localities where a wide-ranging and rapidly flowing tide seems to operate unfavorably on the marine vegetation. At Kingsport, Nova Scotia, for example, where the tide has a vertical range of nearly sixty feet, the marine flora is very poor, although wharves and rocks for its attachment are not altogether wanting.

In the writings of Horace, the old Latin poet, the phrase "vilior algâ" occurs, indicating that a seaweed was, even in his day, considered to be the climax of futility and worthlessness and that when one had said that anything or anybody was more worthless, useless, and cheap than a seaweed, one had gone about as far as the Latin language would carry one! And this idea has apparently persisted, more or less, in the popular mind at least, down to the present day, even though in some parts of the world it is well and generally understood that certain seaweeds serve very useful purposes. Although the seaweeds of the United States have not thus far been of much importance from the financial and economic point of view, it was quite otherwise a hundred years or more ago in Scotland, Ireland, and northern France, and is still quite otherwise to-day in Japan. In northern Scotland especially, and more particularly in the Orkney Islands and the Hebrides, the so-called kelp industry from about 1720 to 1830 was lucrative and important. The word "kelp" to a modern English-speaking botanist suggests in particular one of the larger seaweeds of the family *Laminariaceæ*. But the word has had and still has a wider signification, meaning primarily some of the larger brownish or olive-green seaweeds and secondarily the ash derived from burning these seaweeds. This ash contains large quantities of "potash" and "soda," or potassium and sodium salts, and was for many years extensively used in manufacturing soap and glass and to a less extent is still so used in the British Isles. And until recent years this kelp ash has been the chief source of the iodine of commerce. The inhabitants of the Orkneys and the Hebrides, off the north coast of Scotland, used to get a large part of their living from burning seaweeds and selling the ash. It is said that in the Hebrides a century ago the first toast to be drunk on festive occasions was "A high price to kelp and cattle." The general popular sentiment in favor of selling high and buying low was apparently as pronounced in the Hebrides a hundred years ago as it is in the United States to-day! In the height of the prosperity of the kelp industry, Scotland is said to have derived from it an annual income of about two million dollars. The kelp industry was for many years an important one, also in parts of England, Ireland, northern France, Norway and Denmark. During the more prosperous period of this industry, the value of the seweed crop on the coast of Brittany is said to have reached a million dollars a year. But after a time the soapmakers and glassmakers, or their collaborating chemists, found it cheaper to convert common salt into sodium carbonate, the potash salts began to come into the market from the natural deposits in the Stassfurt region of Germany, iodine was derived more cheaply from the saltpeter beds of Chile, and the kelp industries of northern and western Europe began to decline. However, the brown seaweeds are still gathered for their iodine on the coasts of Japan, Scotland and Ireland, and kelp-burning remains an industry of some little importance in these countries. The species of *Laminaria* and *Ecklonia* (Japan) are particularly rich in iodine, though other members of the Laminariaceæ and various rockweeds (species of *Fucus* and *Ascophyllum*) are sometimes included in the burning. In Ireland, according to Cotton,[1] "the 'rods' (stipes) of the various *Laminariæ* employed are collected as they are cast ashore in autumn, winter and spring, and placed on stone walls till burning time.

The use of seaweeds as a fertilizer for the soil has been in vogue for centuries among farmers living in the vicinity of the sea. In parts of the British Isles, France, Norway, and Denmark, in particular, the beneficial effects of the marine plants as a soil fertilizer have long been recognized. In northern France there used to be conflicts between those who wished to gather the seaweeds for fertilizer and those who wished to burn them for the ash—a matter that had to be regulated by laws. On the coast of Brittany in France and on the west coast of Ireland it is not unusual to see farmers and gardeners carting away seaweed from the shore to be used as a fertilizer for the land. It is used chiefly by the farmers living near the sea, though it is sometimes carted as much as seven or eight miles inland.[2] In Ireland, the weed is applied to potato beds previous to planting, and a dressing of seaweed is often applied in spring or autumn to grass land and grain fields. In many places the loose seaweed that drifts in at certain seasons, especially during and after storms, is sufficient for the farmers' requirements; in other places, it is cut by hand from the rocks; and in a few localities in Ireland it is actually cultivated for use as a fertilizer. It seems that for this purpose places that are more or less level, sandy, and destitute of weeds are selected and that stones are planted out between the tide lines for the seaweeds to grow on. The stones are set out in rows with paths between for convenience in harvesting and carting. The rockweed, here mostly of one species, appears of itself on these stones from the fertilized eggs or sporelings that are floating about in the water and finally attach themselves. The seaweed is cut in February and March when it is two years old and the stones are then turned over for another crop.

In the United States the practice of using seaweeds as a fertilizer for the soil is especially well established in Rhode Island, in which state the Agricultural Experiment Station has issued a bulletin[3] on the subject. At Rye Beach, New Hampshire, the farmers attribute their unusual success with red clover to the fact that they cover the land with seaweed and plow it under, a practice that has obtained since the founding of the colony.[4]

The beneficial effects of seaweeds when applied to the soil were demonstrated by practical experience centuries before it was really understood just in what way the good effects were brought about. But it is now well established that their fertilizing qualities are due chiefly to the "potash" or potassium salts that they contain. Potassium, nitrogen and phosphorus are elements that plants must find in the soil if they are to grow and thrive, and of these three essential elements the seaweeds supply potassium in special abundance. In addition to supplying potassium, the application of seaweeds in bulk appears to have a desirable physical effect upon the land. Most of the algæ on being dried and then soaked out with fresh water swell enormously and when they are turned under by plowing this quality is of advantage, especially on a light dry soil, as this sponge-like action of the seaweeds holds small reservoirs of water in close contact with the roots of the cultivated plants. The potash that has gone into the commercial fertilizers used by the farmers and gardeners of the United States has come almost wholly from the mines in the Stassfurt region of Germany, a region that represents a former sea-bottom where various soluble potassium salts have accumulated in a solid form by the concentration and final drying out of the sea-water. The Stassfurt mines up to the beginning of the present deplorable war have been the one important source of the potash supply of the world. Under the German conservation laws the amount of potash salts that may be mined each year has been limited and the proportion of the annual product that may be sold outside of Germany has also been limited and prescribed. The United States has supplies of phosphate rock sufficient for its own use and for export for centuries to come, but for potash the farmers of the United States have been almost wholly dependent upon Germany ever since they began to use artificial fertilizers. Previous to the great war, the United States was importing from Germany potash to the value of twelve millions of dollars or more annually. Three or four years before the war broke out there was some trouble between the American importers and the German "Kali Syndikat" over the raising of the price of potash and the threatened curtailments of the amount that was allowed to be shipped to the United States. This incident, among other considerations, led the United States Congress to instruct the Bureau of Soils of the Department of Agriculture to investigate the possibilities of developing within the boundaries of the United States a supply of potash that would meet the domestic needs and thus make the United States independent of any foreign nation in this important matter. To many, it might not seem that all this had anything to do with seaweeds, but it turned out that it did. The first and most natural steps to discover sources of potash with commercial possibilities led in two directions, first to the alkaline basins of our arid west, especially where the surface alkali included potash salts, but this search has not thus far resulted in discovering any deposits of commercial importance, though borings at several points are still, I believe, being made by the Geological Survey. The second obvious trail led to the feldspar and granite rocks of the United States, which contain potassium in immense quantities, but in the form of insoluble compounds. It is quite possible to separate out this potassium and convert it into soluble compounds, but thus far the cost of doing it put these rocks outside of the commercial possibilities as a source of potash for the gardener and farmer.

The Washington scientists, in looking about for an independent American source of potash, finally took into consideration the long-established use of seaweeds as fertilizers for the soil, and they began to investigate the extensive grooves of kelps on our Pacific coast and to determine with some degree of accuracy the amount of potassium salts contained by them. One of the most important of these great kelps of the Pacific is *Nereocystis*, known also as the "bladder kelp," the "sea-otter's cabbage," the "bull kelp," and the "ribbon kelp." This kelp forms in places extensive groves or beds from Point Concepcion, near Santa Barbara, Cal., northward to the region of the Aleutian Islands of Alaska. The plant grows attached to the bottom in water that is from ten to one hundred feet deep and it thrives especially where there are strong currents of water or active wave movements. The plant has a long slender stalk, terminated above by a more or less globose hollow enlargement that is filled with air or gas, the chemical composition of this gas varying according to the time of day, as has recently been shown. Several long blades or leaves spring from the top of this floating vesicle. Some rather large stories have been told about the length attained by this *Nereocystis*. Kjellman in "Die Natürlichen Pflanzenfamilien" of Engler & Prantl, apparently using figures given by an earlier writer, states that the plant gets to be 100 meters long, but several observers who have had unusually good opportunities for studying the plant have expressed the opinion that these figures have been exaggerated. Prof. William A. Setchell has stated that the longest individual of this species seen by him spanned 41 of his paces, which, he says,[5] "fully equals that number of meters." This remarkable length was probably the result of a single season's growth, as, in most cases at least, *Nereocystis* appears to be an annual

*Abstracted and adapted from an illustrated lecture given at the New York Botanical Garden on September 25, 1915. From the *Journal of the New York Botanical Garden*.

[1] Proc. Roy. Irish Acad. 31[B]: 152. 1912.

[2] Cotton, loc. cit. 153.

[3] Wheeler, H. J., & Hartwell, B. L. Seaweeds. Their agricultural value, and the chemical composition of certain species. R. I. Agr. Exp. Sta. Bull. 21: 1–37. *f. 1–11.* 1893.

[4] Turrentine, J. W. The technology of the seaweed industry. In: Fertilizer resources of the United States. Senate Document, No. 190. 1912.

[5] Bot. Gaz. 45: 126. 1908.

plant. This rapidly growing bladder kelp is, so far as abundance and massiveness are concerned, the most important seaweed from Puget Sound to the Aleutian Islands. The analyses made by the chemists of the Bureau of Soils in Washington show that from twenty-seven to thirty-five per cent of the dry weight of this particular kind of kelp consists of potassium chloride.

Another large kelp of the Pacific coast that is rich in potash is *Pelagophycus*, the "elk kelp," the "sea pumpkin," or "sea orange," which is a close relative of the *Nereocystis*, but is more southern in its range, occurring from Point Concepcion, near Santa Barbara, southward to Lower California. There is apparently, however, not enough of this to make it of much potential importance as a source of potash.

But the kelp of our western coast that from its general abundance and massiveness seems likely to be of the most importance as a source of potash is *Macrocystis*—known also as the "great kelp"—a name that it seems to deserve even when compared with other kelps of giant dimensions. This grows attached to the bottom in water that is mostly from twenty to seventy feet in average depth. It occurs in such large compact beds that it sometimes forms natural breakwaters for harbors, as at Santa Barbara. It impedes navigation with rowboats and, by becoming entangled with the propeller, sometimes even with steamboats. Stories of this plant's attaining a length of 700 feet or more have found a place in scientific literature, but the greatest length of a single plant so far as yet determined by actual measurement is, I believe, about two hundred feet. The species persists through the winter and appears to be perennial in habit. It is abundant, locally at least, from Lower California to southern Alaska.

During the past four or five summers the Bureau of Soils has surveyed the kelp beds of California, Oregon, Washington, and Alaska, has published an extensive series of maps of these kelp beds in the two reports that have been mentioned, and has estimated the bulk of the gross material represented by these beds. Analyses of the principal kinds of western kelps from various localities have also been published, with special reference to their potash and iodine content. As a result of these surveys and analyses, the officials of the Bureau of Soils and of the Department of Agriculture are enthusiastic as to the future economic importance of our Pacific coast seaweeds.

The mechanical difficulties connected with harvesting and drying the large kelps of our Pacific coast for subsequent use as a fertilizer seem on the point of being solved. The report on "Potash from kelp" includes description and photographs of a harvesting machine that has been in actual and successful operation near San Pedro, Cal. The machine has a toothed scythe-blade of the ordinary mowing-machine pattern that runs horizontally four feet below the surface of the water and there are also two shorter blades that run vertically at either side. The cut kelp falls on an endless belt, is brought over the side of the machine, and falls into a sort of hopper where it is cut into short lengths by another set of knives. There is then a conveying apparatus that brings the cut kelp to an open barge lying alongside and this barge is finally towed to the dock, where its load is discharged. A launch pushes the mowing machine through the kelp beds at the rate of about four miles an hour, and the machine is said to be able to cut 25 tons of fresh kelp an hour. Several companies have already been organized in California for harvesting kelp and making agricultural fertilizers from it. Some of the companies are using chemical processes for extracting the potassium chloride and iodine, while others are simply drying the kelp and using all of it for applying to the soil. In the latter case, the nitrogen as well as the potassium content is saved and used. It is said that the present unhappy demand for exploisves has led an important company engaged in their manufacture to resort to the Californian kelps as a source of a part at least of its supply of potassium.

Various kinds of seaweeds are used as articles of food in different parts of the world, but it is only in Japan, China, and Hawaii that they form an import item in the diet of the people. In the United States, among the native-born population at least, the kind that is chiefly, though not very widely, used is the "Irish moss" or "carrageen" (*Chondrus crispus*), one of the "red seaweeds." On the coasts of Massachusetts (especially at Scituate) and New Hampshire, this "moss" is collected dried and shipped away in barrels, for making "sea-moss farina," puddings, blanc mange, or jellies. The final product is very palatable, especially when suitably flavored, and served with sugar and cream. It enjoys a certain amount of vogue with invalids as well as with others. This Irish moss was formerly used by the brewers in this country for clarifying beers, but I understand that they have now found substitutes for it and that consequently the Irish moss industry on the coast of New England is now less prosperous than formerly.

The dulse or dilsk (*Rhodymenia palmata*), another of the red seaweeds, may often be found in a rough-dried state in the waterfront markets of New York, Boston, and other cities of the United States. Those who like it commonly eat it raw and dry as a sort of salad or relish. It is said that some of the Irish and Scotch were more addicted to chewing it in the older days before tobacco and chewing-gum became so common and popular. In Ireland and Scotland it is sometimes cooked. Certain Scotch gentlemen have been quoted as saying that "a dish of dulse boiled in milk is the best of all vegetables."

Dr. T. C. Frye, professor of botany in the University of Washington, and C. E. Magnuson of Seattle hold a patent for the manufacture of an edible product, somewhat resembling candied fruit, from the stalks and vesicles of *Nereocystis*. This looks and tastes a little like preserved citron and the trade name for it is "seatron." The potassium chloride and other soluble salts are removed by treatment with fresh water, sugar is introduced in their stead, and flavoring extracts such as lemon, orange, etc., are added. The final result is really very toothsome and the first samples of it received for exhibition in a museum show-case of the New York Botanical Garden never reached any show-case.

The Japanese make use of certain kinds of sea plants (*Gloiopeltis* sp.) as the source of a sort of glue that they call "funori." This is produced in Japan to the extent of two or three million pounds a year and is there rather extensively used in the manufacture of sizing for cloth. For this purpose it appears to have certain advantages over starch. It is said to fill the cloth better, to be tougher, more elastic, transparent when dry, and not much affected by acids. It "imparts to the goods a thick clothy elastic feeling" without the stiffness that comes from the use of starch.

At the present day it is chiefly in Japan that the collecting and growing of seaweeds for food and for other purposes has attained the proportions of an important industry. One of the more important edible products of the Japanese algæ is "kanten" or "Kant-Ten," which is derived from species of *Gelidium*, a genus of red algæ that has representatives on the coast of the United States also. In its manufactured form it is a white semi-transparent, tasteless, and odorless substance, and is sometimes known as "seaweed isinglass." It is used in Japan, China, and India as an ingredient of soups and sauces and is also served as a dessert and fashioned into a sort of candy. A part of the agar-agar of commerce, the glue-like or jelly-like substance that is so well known in American laboratories as a culture medium for bacteria and fungi, consists of this Japanese "kanten." The word "agar-agar," however, appears to be of Ceylonese origin, and the agar-agar of our laboratories originally came and still comes in part from the "Ceylon moss" of southern India, which seems to be chiefly *Gracilaria lichnoides*, belonging also to the red algæ but representing a different family from the species of *Gelidium*. It is probable that still other sorts of seaweeds contribute to the making of agar-agar as sold in the markets of Europe and America, a circumstance that doubtless goes far to explain the somewhat varied and inconstant behavior of this substance as a culture medium.

Even exceeding "kanten" (*Gelidium* sp.) in importance as a food product in Japan is "kombu," which consists of various kinds of kelps, *i. e.*, larger brown seaweeds, chiefly of the family *Laminariaceæ*. The kelps of Japan are so large as some of those of our Pacific coast, even though some of them are said to approach 100 feet in length. The gathering is done mostly in the late summer and in autumn and is done by men working from boats with hands, hooks, and dredges. The dried product is placed upon the market in various forms, raw or cooked, some of them being palatable and agreeable to foreigners, others not so much so. Smith[6] remarks that "Kombu enters into the dietary of every Japanese family, and is one of the standard foods of the country, the various preparations having different flavors and being used for different purposes." Most of these preparations are cooked with soup or are boiled and served with fish; some of them are used in the manufacture of confectionery. Large quantities of kombu are exported to China.

Another type of seaweed that is of much importance as a food in Japan is found in one or more species of the genus *Porphyra*, which belongs with red algæ. This is known as "amanori," "Asakusa-nori," or simply as "nori," which appears to be a general Japanese term for seaweed. "Laver" or "red laver" are English names for the same or closely related species. *Porphyra* is not only gathered from its natural haunts in Japan, but it has actually been cultivated for many years, especially in the region of Tokyo, and the cultivated crop is the present chief source of supply. Brush or twigs are set out in shallow water (preferably brackish) in protected places and in the winter the young *Porphyra* plants appear on these twigs, from which the mature plants are harvested from January to March. There are said to be more than 2,000 acres along the coast of Japan that are devoted to the cultivation of *Porphyra*. Girls and women do most of the work of collecting and drying the plant. *Porphyra*, served in various ways, is a prized article of food throughout Japan. About one-third of the dry weight of *Porphyra* is protein, so that it is a rich food, which apparently is more than can be said of most of the seaweeds.

Several kinds of marine algæ, other than those here mentioned, are used in Japan as articles of food. Statistics as to the less important kinds and also as to the kenten, kombu and amanori consumed directly by the families of the fishermen and seaweed-gatherers are not obtainable. It is, however, surely no exaggeration to place the annual value of the seaweed crop as harvested in Japan at $3,000,000. Nothing at all approaching this, in an economic way, has as yet been done with the sea plants of the United States, but with the urgent demand for potash now arising from our farmers and gardeners, and with our usual sources of supply cut off by the war, it seems within the bounds of reasonable probability that the great kelps of our Pacific coast will soon yield even richer harvests than do the seaweeds of Japan.

[6] The Seaweed Industries of Japan. Bull. 24: 133-165.

Chemical Properties of Molybdenum

METALLIC molybdenum is only slowly oxidized at ordinary temperatures, and drawn molybdenum wire retains its luster almost indefinitely. On prolonged heating at a dull-red heat it becomes covered with a white coating of molybdic trioxide, and at 600 deg. Cent. it oxidizes rapidly and the trioxide formed sublimes.

Fluorine attacks molybdenum at ordinary temperatures, chlorine at a dull-red heat, and bromide at a cherry red, and iodine does not attack it appreciably at temperatures as high as 700 deg. to 800 deg. Cent. Molybdenum is readily attacked by nitric acid but is not effected by hydrochloric acid, and sulphuric acid attacks it only when hot and concentrated. Fused alkalies act only slowly on the metal, but fused oxidizing salts, such as potassium nitrate, sodium peroxide, and potassium chlorate, attack it rapidly.

Molybdenum combines with oxygen to form several oxides, the three most stable of which are the sesquioxide (Mo_2O_3), the dioxide (MoO_2), and the trioxide (MoO_3). The first two of these are basic, and few of their salts have been studied. The trioxide is acid. It is yellow when hot and white when cold. It is precipitated from solutions in hydrated form by nitric and hpdrochloric acids, bute is soluble in dilute sulphuric acid and the alkalies. When the hydrated oxide is gently ignited, it becomes dehydrated and much more difficulty soluble in dilute acids. When the trioxide is heated, it sublimes, sublimation commencing at 400 deg. to 450 deg. Cent.

A large number of elements combine with molybdic oxide to form molybdrates. Of these, sodium molybdate, Na_2MoO_4, potassium molybdate, K_2MoO_4, and ammonium molybdate, $(NH_4)_2MoO_4$, are the chief soluble salts of molybdenum. The first two of these are formed by fusion of the trioxide with the requisite amount of sodium potassium carbonate. The latter is formed by the action of concentrated ammonia on the trioxide. The heavy metals, such as barium, calcium and lead, form molybdates which are insoluble, and use of this fact is made in analytical work. Besides the normal molybdates of the form X'_2MoO_4 many complex molybdates such as phospho-molybdates exist.

With the halogens molybdenum forms several compounds which vary greatly in stability. One compound, MoO_2HCl, is of importance as it is volatile at 250 deg. Cent. and its formation affords a means of separating molybdenum from tungsten.

Molybdenum forms two principal sulphides, MoS_2 and MoS_3, both insoluble in dilute sulphuric and hydrochloric acids. These sulphides dissolve in the alkalies to form thiomolybdates of the order X'_2MoS_4, which react with acids to form sulphuric, hydrogen sulphide, molybdenupm disulphide, and molybdenum trisulphide.

Molybdenum combines with nitrogen, phosphorus, boron, carbon, and silicon. More complete references on the chemical properties of molybdenum are given by Roscoe and Schorlemmer,[1] who have been quoted freely in the foregoing discussion. Moissan[2] also gives detailed data on the chemistry of molybdenum.—*Bulletin 111, Bureau of Mines.*

[1] Roscoe, H. E., and Schorlemmer, C., A treatise on chemistry, vol. 2, 1913, pp. 1059-1082.

[2] Moissan, Henri, Traité de chimie minérale, t. 4, 1904, pp. 685-758.

Mahogany trees planted for shade in Paramaribo

Hauling mahogany logs to the landing in Costa Rica

The Mahogany Tree

Most Valuable Member of Tropical American Forests

By C. D. Mell

THE mahogany is the most valuable of all the tropical American trees. It can easily claim supremacy as the King of the forest. In beauty and stateliness it has no rival in its native habitat. Its trunk is not so massive as those of some of its neighbors, but it frequently attains a much greater height. The mahogany tree is tall, straight, symmetrical, rearing its crown often more than 100 feet high and is preeminently useful for its timber, which is employed for fine furniture, interior trim of luxurious residences and for all purposes in which beauty and durability are required. For the variety of special and common purposes in which it is employed, it may be regarded as the most useful wood and is always in the highest request. The wood is often curiously veined and is capable of taking an exquisite polish and is, therefore, used extensively by makers of the most exclusive types of furniture and of cabinet work. Mahogany is unmatched for beauty and usefulness by any other wood of the West Indies; moreover, its worth is enhanced by its comparative rarity, for the ax has played havoc with the most accessible trees.

Mahogany is a name given to several distinct species of timber-yielding trees of tropical America; one is the Spanish or small-leafed mahogany (*Swietenia mahagoni*), which was first discovered and exploited in Cuba; the other is the large-leafed or Mexican mahogany (*Swietenia macrophylla*), which is found chiefly in southern Mexico and in British Honduras, the wood of which entered the trade much later than that of the small-leafed variety. The Mexican mahogany was not recognized by botanists as a distinct species until long after dealers and users of the wood had called attention to the fact that it was much softer and lighter, both in weight and color, than that of the Spanish mahogany from Florida and the West Indies. For a long time the softer grades of the Mexican variety were known in the trade chiefly as bay, baywood or bay mahogany, which meant that the wood was false or so-called "near" mahogany. A dwarfed variety that is said to be growing sparingly in the elevated parts of southern Mexico is the ground mahogany (*Swietenia humilis*). While the wood of this species is hard and beautifully textured, it is not exploited, both on account of its small size and inaccessibility. The mahogany growing in Panama and Colombia is a fourth variety, whose botanical identity has not yet been determined. The so-called Panama mahogany may be described as being intermediate between the Spanish and Mexican varieties.

Although mahogany comes from several distinct botanical sources, it is graded in the market largely without reference to whether it is the wood of one species or of another. Timber merchants and wood users are interested primarily in the geographical origin of the wood, which affords them a clue as to its quality, because experienced mahogany users are familiar with the merits of the wood obtained from different regions. The grades of mahogany on the market are designated according to their places of growth, or oftener to their ports of shipment. In a general way it may be said that the small-leafed kind, which is found chiefly in Cuba, the West Indian Islands and in elevated parts of the Spanish Main, is noted for its beauty of grain and figure, which constitute the chief characteristics by which mahogany buyers judge the quality or grade of the wood. If the wood is derived from the West Indies and is of required sizes, it is at once graded as figured wood of good quality. The large-leafed variety is obtained from the lowlands in southern Mexico and British and Spanish Honduras. The wood usually is softer, lighter and often lacks the unique figure that characterizes the mahogany from the uplands.

Small leaf mahogany, showing character of the bark

The exploitation and export of mahogany constituted at one time the principal resource of tropical American forests. For many years the supply seemed inexhaustible, but authorities on the world's supply of timber are now fearing a great diminution in the output from the forests and on the market. Serious apprehensions are entertained, even by those engaged in the mahogany business that the scarcity of this timber may lead to the employment of a still greater number of other woods instead of true mahogany and to the displacement of the West Indies from its position as the world's principal source of supply of this class of timber. The African, Philippines and Central and South American woods which come into the American markets are now being used extensively as substitutes for true mahogany for various purposes for which the latter has hitherto been employed.

While the imports of so-called mahogany to the United States have risen in recent years to more than 40,000,000 feet annually, that of true mahogany has fallen to not more than 12,000,000 or 15,000,000 feet. The Philippine mahoganies have made considerable progress in the American markets during the last two years. Approximately 2,000,000 feet of the best grades of Philippine kinds have been entered at the port of New York during 1914 and 1915. West Africa supplies annually more than seven times this amount. As the supply of these mahogany-like woods from other parts of the world increases, the exports of true mahogany from tropical countries will decrease. The probable future falling off in the export of true mahogany must naturally be attributed also to other causes, as follows:

1. The diminishing number of trees of large dimensions in the forests.
2. The increasing cost of obtaining the timber, owing to the necessity for penetrating the less accessible forests in search for timber.
3. The increasing cost of labor, equipment and transportation.

Fortunately the mahogany tree has a very wide natural range of growth. It thrives in every country bordering the Caribbean Sea, and has been found and exploited on practically all of the Islands of the West Indies. It is native to the keys and to parts of the mainland of extreme southern Florida. In Mexico it occurs from Tampico southward extending into Central and South America. It is difficult to say just where mahogany occurs in commercial quantities south of Panama, but it has been exploited along the Magdalina River in Columbia. A dwarfed variety is indigenous to Venezuela, where it is found most abundantly in abandoned fields and along fences. So far as is known now, true mahogany has not been found growing naturally in the Brazils and in the Guianas, nor does it extend into Peru; the so-called Peruvian mahogany that comes occasionally into the American markets is a generically different wood.

In Florida mahogany is confined to the keys and the well-drained areas of the mainland, which seldom overflow and which have a limestone substratum rendering the soil conditions almost similar to the mahogany-producing regions in Cuba. The trees here are not so large as they are farther south, and the wood is considerably harder and has been classed by experts as the finest mahogany obtainable.

The tree is found also in the Bahamas, where conditions are nearly similar to those in Florida. The wood is called maderia on the Island of Andos, and was for a long time believed to be different from that of the Cuban variety. It is very hard, heavy, and dark colored, and is highly esteemed in the trade. There is very little mahogany left on the island, and practically all the trees are now cut and utilized locally. Originally Cuba, Haiti and Jamaica supplied all the mahogany used in Europe and the United States. Porto Rico has produced very little, if any. The small islands in the Lesser Antiles contain some mahogany, but it is used locally. In Trinidad the supply is also very limited, though formerly a good deal was exported to England.

The wood from Cuba and Santo Domingo is known as Spanish mahogany, which has always been considered the most suitable for making luxurious furniture. It possesses the finest texture and has in a marked degree

Hauling mahogany logs in the forests of Mexico

Large mahogany trees in Mexico

the chemical properties that cause the wood to mellow and improve with age, giving it a tone and charm that are distinctly its own. It has a reputation of being harder, darker and more figured than that from any other locality. In fact, the variety of color and diversity of figure are marvelous and special logs often fetch high prices. A log handsomely figured, if of good texture and color, commands as high as $400 or $500 per thousand board-feet. The different figures quite common in the best logs from Cuba are technically known as roe, mottle, cross mottle, dapple, fiddle back, plum pattern, bird's-eye and curls. The figure constitutes in part the quality that fits the wood from the highest purposes in decorative art.

Cuban mahogany has always been considered to be the best in the market. The commonest grades were sold at from $110 to $180 per thousand feet. The finer grades of figured mahogany have been sold for as high as $500 per thousand feet, and a few very fine logs have brought even as high as $1,200 per thousand feet. Mahogany is found throughout the Island, where it has been exploited for more than 200 years, but the best and most accessible trees have been cut. There is still a good deal of excellent timber available in the interior but the bulk of the logs now coming from Cuba are much smaller than those from some other mahogany-producing regions, and, consequently, bring smaller prices. The material consists largely of such logs as were not accepted by former exploiters of the wood. While it has the reputation of being harder, darker, and more figured than that from any other region the wood is often sold now for less than $50 per thousand feet in New Orleans and Mobile.

Peurto Principe and Santiago de Cuba produce more mahogany for export than the other provinces of Cuba. Prior to the American occupation the average quantity of mahogany exported to the United States from Puerto Principe during a prosperous year was about 135,000 feet. The total export varies considerably, as is shown by the following figures compiled from official records:

Year	Export in feet
1890	62,500
1891	578,000
1892	1,240,000
1893	1,180,000
1894	542,000
1895	31,500
1896	54,642

The mahogany industry in Cuba was greatly developed soon after the period of insurrection. From 1895 to about 1900 the conditions of the Island were not normal and caused great confusion in trade and development of its industries, but the mahogany industry soon expanded and the imports into the United States increased. For the five-year period ending June 30, 1915, the imports of mahogany according to figures of the Bureau of Statistics, United States Department of Commerce, are as follows:

Year	Quantity	Value
1911	2,976,000 feet	$187,493
1912	3,256,000 feet	201,923
1913	5,395,000 feet	338,996
1914	2,988,000 feet	193,692
1915	1,607,000 feet	98,334

After better transportation facilities to the seaboard are available in Cuba, enormous quantities of fine mahogany, which is still in existence well inland, will be brought to market. To reach a shipping port, only small logs can at present be hauled over the rough roads.

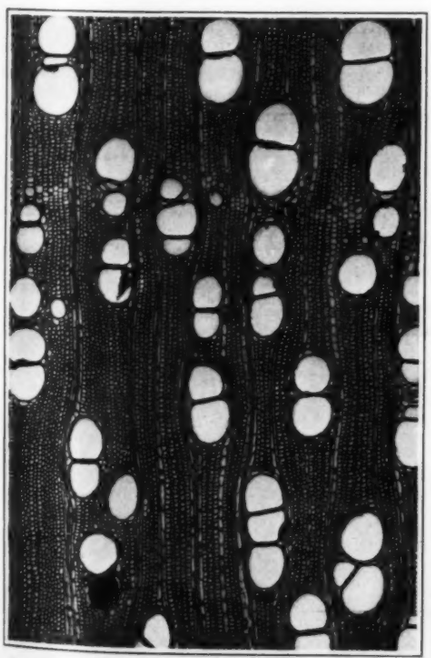
Hayti has extensive forests which contain good mahogany. Little of it has thus far been exploited on account of the unstable government. Foreign timber companies have found it difficult to obtain a clear title to timber grants. The soil and climatic conditions are favorable to the best growth of mahogany, and after better means of transportation have been developed, large quantities of the finest mahogany will be made available. There are at present no figures extant on the export of mahogany from the island.

Mexican mahogany trees planted in Trinidad

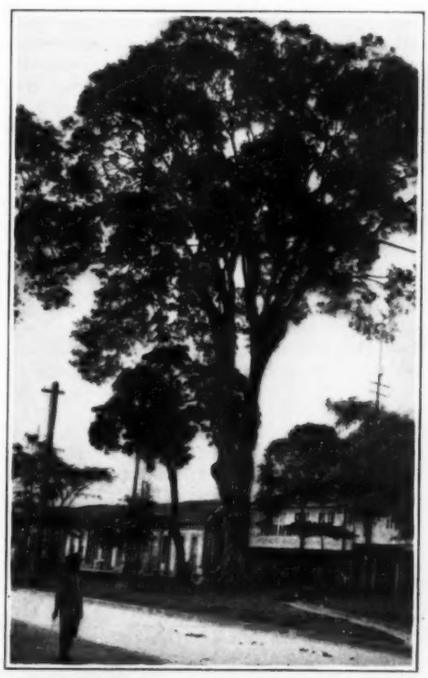
In Jamaica mahogany was at one time a very common tree and large quantities of the wood were shipped to England. Trees of all ages, without any foresight as to the future supply, were cut down and exported. As early as 1753 more than 500,000 feet in planks were shipped from Jamaica. As a result of this ceaseless deforestation, Jamaica has very little mahogany to spare. The wood is of fine quality and is said by some to be equal to that obtained in Cuba and Santo Domingo.

Southern Mexico and British Honduras have soil and climatic conditions which favor the best development of the large-leafed mahogany. In these forests mahogany forms only a small proportion of the timber trees. In the uplands mahogany is diffused throughout the general forests in the proportion of about one to five hundred of other trees, while in the lowlands it is found in the proportion of about one to three hundred, not equally diffused, but confined to certain localities of small extent, where it occurs more frequently than in other places. These localities are the warm southern or eastern slopes; sometimes it ascends to ridges, and when these are sheltered, to the north and west by higher hills, presenting a free southeastern aspect, mahogany assumes a larger size.

It is quite obvious that a tree depending on so many local peculiarities for its full development cannot occur continuously to any great general extent, yet the quantity of mahogany in these forests has been and still is very great, although the lower forests bordering the navigable streams have been heavily worked and the best mahogany is now to be found only up in the forests where its removal is more difficult. This observation applies to all the regions where mahogany grows. Still the numerous streams and rivers which rise in southern Mexico afford



A transverse section of Mexican mahogany, magnified 50 diameters



A massive mahogany tree showing character of growth in the open

splendid facilities for floating the logs, even from their extreme sources in the rainy season.

The soil in which the mahogany grows presents the same uniformity as to geological structure. In the forests where the best mahogany is found the soil is a clayey loam, derived from the dark limestone. In the lowlands the soil is composed of an alluvial deposit on which mahogany is not found in the same perfection, though the trees are often much larger than on the uplands. This difference in the quality of wood is attributed to the character of the soil. The trees grow more rapidly in the lowlands, and the wood is softer and possesses less figure. Nearly all other varieties of timber associated with mahogany partake of the same peculiarity and attain a much larger size in such localities than they do in the hills.

Those who have watched mahogany trees from year to year have observed that their rate of growth, like that of all other of all other trees, varies exceedingly, according to the locality and soil. A mahogany tree grows fastest in deep alluvial soil, where the roots can spread far and deep and the leaves remain green all the year round. Young trees grow very rapidly, often as much as one-half an inch in diameter a year. Young seedlings planted in good soil are known to have made uncommonly rapid growth. In a small plantation of Mexican mahogany in the Philippine Islands the trees attained a diameter averaging about 6 inches during the first ten years. Trees planted in Trinidad in 1900 are now from 10 to 11 inches through a foot above the ground. The Mexican variety was introduced also into India, where it is said to grow very rapidly under favorable conditions.

On the other hand, mahogany grows very slowly on well-drained ridges or in poor soil where the majority of trees remain stunted and sometimes die off before reaching a merchantable size. They seldom attain a diameter of over 18 inches, although the forest has never been interfered with either by fire or ax. Mahogany of this description is found on the dry limestone soil on the hills at the heads of the streams in southern Tabasco and in the far interior of British Hondurus. Full-grown mahogany trees growing in good soil have an average diameter above the root swelling of about 3 or 4 feet.

It is difficult to say just how old a mahogany tree is when it arrives at maturity, but a tree 3 feet in diameter is probably not less than 200 years old. No one has ever made any reliable measurements of the annual rings of growth. Authorities on questions relative to the rate of growth of trees in the tropical climates state that in warm countries where the alternation of seasons is less marked than in the temperate climate, no dependence can be placed in this test of the age of the trees. Toward the northern limits of its range, mahogany shows well-marked annual rings of growth. This is particularly the case in southern Florida and in the mountains of Cuba and Mexico. While it is difficult to determine the age of mahogany by the rings exhibited in transverse section, there can be no doubt that the rate of annual increase in diameter varies very much in different parts of the tree's range.

The mahogany from this part of the mainland varies. The best is what is known as the Tabasco. The logs coming from Fronteras and Laguna are good, and the wood has a very large demand both in this country and in Europe. The growth of logs shipped from Tuxpan and Progresso are usually of what are termed *cazones* growth, which results stringy and is more difficult lumber to finish, and, in consequence, is sold at much less than the woods from other ports. The shipments from Purto, Mexico, are probably derived from the west coast. The texture of these logs is somewhat harder than that of the east coast and not as well liked, and, in consequence, the values are somewhat less.

The exports of mahogany from Mexico during the last five years are as follows:

Year	Quantity	Value
1911	11,935,000 feet	$706,498
1912	10,596,000 feet	616,912
1913	10,866,000 feet	664,705
1914	10,381,000 feet	785,148
1915	8,119,000 feet	488,740

British Honduras on an average exports as much mahogany as Mexico. The wood is approximately of the same character, though in point of size the Honduras wood is excelled by the Tabasco variety. The latter yields fine texture wood with good color. The wood from regions including that from Spanish Honduras, comes to market in large sizes and is, therefore, adapted for large work. Their silky texture, along with a general freedom from serious heartshakes, causes the wood to be much appreciated.

The Nicarguan mahogany is obtained from somewhat smaller trees and the logs formerly came into the markets in the round state. During recent years very little of this wood has been received. The wood was considered to be of excellent quality, with a mild texture resembling somewhat that derived at present from Panama. The shipments received from Guatemala, Costa Rico and Columbia are very variable in quality, but the bulk of the material is good wood commanding good prices.

The American Egypt

SCATTERED all over the Yucatan peninsula are monuments to a civilization that flourished thousands of years ago. Just how many thousand nobody knows and scientists differ very materially in their ideas on the subject, says Mr. George Miner in the *Mexican Review*. The prevailing belief, however, is that this civilization was in full swing as late as the beginning of the Christian era. Other scientists assert that the ruins antedate those of Egypt.

Yucatan can well be called "The American Egypt." The ruins of 172 cities, big and little, have been discovered and not a quarter of the territory has been explored, that is, carefully explored, for the tropical verdure makes the finding of them very difficult. You might pass within a hundred feet of a wonderful old temple or pyramid a hundred times and not discover it, so effectively does the jungle screen these crumbling monuments of the distant past and shield them from the prying eyes of this inquisitive and presumptuous age.

While the ruins of Egypt, through pictures and descriptions, are almost as familiar to the average American as New York's famous skyscrapers, those of Yucatan are practically unknown. They are rarely visited, even by antiquarians, while the casual tourist or tripper never gets there. That is easily understood. They are so difficult of access that none attempt the feat who are not very much in earnest about it.

Of the 172 clusters of ruins discovered, two sets represent what were once large and prosperous cities, of about half a million inhabitants each. Duobtless at different times each one of these two cities was the capital of the country.

One of the cities is Uxmal, pronounced "Ushmul," situated in the southwestern part of Yucatan, and the other is Chichen Itza, in the eastern part of the State. To reach either, the first step is a long railway journey from Merida, and when you reach the point of debarkation from the railway train the real trouble begins.

One is six miles away through the jungle and the other eighteen. In both cases the road leading out is little better than a trail and without question the roughest road that a wheeled vehicle was ever pounded to pieces on.

To my mind the most interesting ruin of all is "The House of the Dwarf" at Uxmal. It is a pyramid, with a temple on top where the priests made human sacrifices. The steps on one side are fairly well preserved. A double chain is run down them so that it is possible to reach the top if you have a cool head. Once there you crawl through a hole knocked in the temple wall and come out on a platform which was the sacrificial altar.

On that platform the priests stood and with knives of flint cut out the hearts of living victims and held the gruesome objects aloft, still throbbing, for the populace below to gaze at. In the great quadrangle at the foot of that side of the pyramid the inhabitants of the city gathered to watch these festal doings. Fifty thousand people could stand in it. Around this huge court runs a palace, two stories high and beautifully carved, which was the home of the nuns, for whose special delectation these sacrifices were made. The nuns were the aristocrats of ancient Maya society.

On all four of the inner sides of this palace are carved two huge snakes, whose bodies are entwined as they twist around the structure. These snakes have human heads and tassels for tails. In all the ruins the carvings are of the same peculiar design. The patterns of the borders and the general ornamentation strongly suggest the Egyptian.

What is most wonderful of all is how they were able to cut those huge blocks of stone and then carve them so beautifully without metal hammers or chisels. There is no iron or other metal in the country and so all they had to work with was flint. How they raised the blocks into place none can explain. That remains as much of a mystery as the pyramids of Egypt. This is used as an argument to prove that the same race of people did them both.

As there is no gold, silver, or precious stones to be found in all Yucatan, it goes without saying that the ancient Mayas had no wealth of that description. Unlike the ancient Peruvians they had no vast stores of hidden gold. Still the treasure hunters will not believe it. These ruins look exactly as though in some sealed-up chambers fortunes would be found. And so the treasure seekers have time and again invaded them and dug away and done a good deal of ruthless despoliation, to find nothing and have their labor for their pains. As soon as the Constitutionalists came into power a stop was put to that sort of vandalage. There are now Indian watchers guarding all the important ruins, and anyone caught prospecting in them is dealt with severely.

There are many more ruins standing at Chichen Itza than at Uxmal, but in both cities all the smaller structures and private houses have disappeared. The ages have worn them away or earthquakes shaken them down and the jungle has covered all. The natural accumulation of soil for centuries has also covered them many feet deep. The bases of the big buildings still in sight are, of course, below the present surface. Not much has been done in the way of excavating, for the government is only just turning its attention to these wonderful relics of the past. In the old Diaz days they were almost ignored. No attempt to preserve them at all was made. In fact, farmers carted away tons of beautifully carved stones to build walls, and there was none to say them nay. It was a good deal easier to pull down a temple and take blocks away already cut than to quarry new ones.

At Chichen Itza there is a temple like a huge round tower that is very curious. In it are four sets of circular stone stairways, one within another. The object is incomprehensible and the method of erection a puzzle to builders of to-day.

For that matter these ruins have several feats in mason work that are beyond our twentieth century architects, such as arches without keystones, leaning walls, round corners, hanging terraces, and so on. The walls are all enormously thick and the rooms rather small, even in the houses of the governors or kings, or whatever they were called. Most of these rooms are now inhabited by bats and are not at all pleasant places. There are no flat ceilings to be found. All are finished with pointed arches.

In only a few places can any idea be had of what the interior decorations were like, as the coating over the rough stones of the walls has generally gone. Where it still remains it can be seen that frescoing and mural painting were the rule. From these paintings, as well as from the carvings, has been obtained the only knowledge we have of the costumes and customs of the people of that day.

The builder, or designer, of each temple or palace put his mark on it in an odd way. It is the imprint of his hand in red dye upon a stone near the main entrance. This hand mark is always found under the final coat of plaster which originally covered the stones. As the plaster has now scaled off the hand prints can be seen. A remarkable thing shown by these old hand prints is that in each case the second and third fingers were of the same length.

Another form of sacrifice for which these ancients had a great predilection was the drowning of young girls. This was considered a great honor, and for a month before the event the selected victim was treated to every luxury and indulgence. Then she was taken to the sacrificial cenote, an enormous natural well in the limestone, 200 feet in diameter and 100 feet deep. She was pitched into this and allowed to drown, while the populace crowded to the edges and enjoyed themselves.

Around the stone platform from which the priests used to hurl the girls several big trees are now growing, loaded with magnificent orchids.

Ancient Rock Carvings in Sweden

AT Leonardsberg, four kilometers from Norrköping, Sweden, there have recently been discovered and cleaned from the surrounding earth a number of rock carvings, both large and small. One of them shows a row of human figures, among others women with children, men bearing shields, horses, and two other quadrupeds with curious head ornaments. Another interesting rock carving has been discovered in Biskopskulla parish in Upland. Six previous carvings were known from this district, but the present one is the representation of a ship of a type hitherto unknown there, since it is not merely outlined but carved on the rock in low relief. About one meter long, it represents one of the so-called dragon ships, and belongs to the oldest group of such monuments of the bronze age, a conclusion confirmed by its height of 32.5 meters above sea level. —*Nature.*

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Intelligence of Ants

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

I would like to add a few interesting observations to those contained in the article "Observations Upon Ants," which appeared in your issue of February 3d, 1917, for I have several times observed ants working in pairs and squads for comparatively long periods of time. The data here given is taken from a diary relating to a colony of *Camponotus Americanus* which I kept in my room for two years.

The observation nest was of the common type, two plates of glass 12 inches square, separated from each other by an half-inch wooden framework. This nest rested on a board 14 by 18 inches, which in turn was placed in a pan 15 by 19 inches. A strip of tin was soldered to the pan all around the board, so as to form a one-inch moat which I kept filled with water. This enabled me to let the ants roam about in the open without much danger of losing them.

I had originally put some soil in the nest with the ants, but when I opened the exits and allowed them out on the island, they began to clear the nest of most of the dirt. At first they deposited the dirt anywhere on the island, but after a while one ant took it upon herself to clear the island instead of going back to the nest with the rest of them for more dirt. Soon a number followed her example. They would take up a pellet of dirt, carry it to the water's edge and leaning over as far as possible, drop it into the water. About a half hour later, I observed two ants who were carrying dirt from the interior of the nest to the entrance where they dropped it. Two others working from the outside, then picked up this dirt and carried it to the moat where they dropped it overboard.

I might also mention that a great deal of the dirt was dropped into the water at one place where it threatened to form a bridge and had to be removed. This same working in pairs I observed on two other occasions when the ants were cleaning their nests of debris.

Another interesting observation and one paralleling M. Charles Jourdan's experience is the following. I had planted a very small Honey-Locust tree in a tin box and placed it on the island. Within a few hours I discovered a goodly number of ants burrowing down into the dirt. One squad was tunnelling the burrows and bringing up the pellets, which they dropped over the edge of the box on to the island below. Here it was picked up by another squad and carried off into the water.

However, in conclusion, I would emphatically state that these actions on the part of my ants, though resembling the rational acts of man do not warrant us in attributing intelligence to these insects. Sometimes it is true, their remarkable ways of acting will cause an uncanny feeling to steal over one. As for instance, when I put a piece of cotton, soaked in Di-Methyl Benzine into a small observation nest and closed its exits. The ants became frantic and some tried to run away, but others "heroically" sacrificed their lives by attempting to carry pieces of cotton out of the nest and that being impossible, to cover it over with dirt and refuse. But all who have read Prof. Wheeler's splendid book entitled "Ants" and Fr. Wasman's S.J. "Instinct and Intelligence in the Lower Animals" will know how to explain these wonders of ant-life without having recourse to "acts of judgment." For we have it on their authority that ants will instinctively carry out any foreign substance found in the nest, or if it be too large, will bury it. If water invade their nest, they will immediately set to drying it by throwing dirt upon it. So likewise when in their their travels they meet with a liquid obstacle, they will often attempt to overcome it by that same instinct that prompts them to keep their nest dry.

JOHN A. FRISCH, S.J.,
Dept. of Biology,
College of the Holy Cross.

Reply to Mr. Norman J. Symons' Article in Scientific American Supplement, Dec. 9th, 1916

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

It seems impossible for Mr. Symons to interpret Bergson. It is also true that Bergson does not always make himself clear even to his own kind of mind.

The essence of Bergson's philosophy is this: Life and mind (the whole of mind) are *one*. Life is one pole of the battery of being and mind is the other. The Life pole is positive, let us say; the Mind pole negative. Thinking which is the action of Mind on Life—whether by means of instinct, intellect, or intuition—Bergson divides into three discrete degrees: Instinct, the lowest evolutionary form of Mind; Intellect, the next higher; and Intuition the highest, each of which evolves out of the next lower.

Thinking in one of these degrees would seem to exclude, for the time being, thinking in the others, but thinking can move easily from one to the other, where mind has evolved to cover the three degrees.

Instinctive thinking alone is done by mind that has not evolved intellect: Intuition is the thinking done by mind that has evolved beyond intellect.

Life (including mind) has two poles, the subjective and the objective, as modern psychology is showing us more clearly every day. Instinct and Intuition belong to the subjective pole, Intellect to the objective, hence intellect can deal with matter only, which Bergson, far from separating from Life, regards as a definite manifestation of Life.

I do not accept Bergson's use of the word "reason." He confounds it with logic. Reason is the pure Life process in thinking—logic is the artificially constructed process formed by the intellect to simulate reason. Reason belongs supremely to Instinct and Intuition—logic to the intellect, hence Instinct and Intuition deal with subjective mind while the intellect deals with objective mind (matter).

Mr. Symons seems to have no adequate conception of the meaning of intuition, as the highest evolution of objective mind. He thinks of it as a sort of "guessing" only. Intuition is not a guessing in the ordinary sense of that word. It is a divining based upon the very highest faculty of mind—not upon logic, to be sure—which only *measures* what *is*, which is utterly unable to create the new, but upon reason which is the life process itself, in mind.

ALICE GROFF.

Cipher Codes

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

I was very much surprised to see in your issue of January 27th, an article on the word square cipher, giving it as new and at least very difficult to decipher. That cipher is not new and has many faults. It is difficult to put into code, it is very liable to error which makes it impossible to decode with the key, it is slow to decode, and by one skilled in deciphering it is easily read. I have seen difficult matter read in less than an hour and a half. You will find a treatment of it in Ball's "Mathematical Recreations." The Playfair cipher which he mentions is preferable in every way. It is faster to write, faster to decode, more difficult to decipher, and less liable to error.

Example: I use my name as a key. When a letter repeats in the key it is omitted.

H	O	W	A	R	Message: Details to in-
D	B	E	N	C	stitutions will be made in
F	G	IJ	K	L	orders from the War Depart-
M	P	Q	S	T	ment.
U	V	X	Y	Z	

Block off in sets of two letters.

DE TA IL ST OI NS TI TU TI ON SW IL LB EM AD EI
fi sr qt yz wg ky ql mz ql ab qa qt gc dq hn iq
NO RD ER SF RO MT HE WA RD EP AR TM EN TZ
ba hc cw mk cb uz wd en hc bq nc zu ik sr.

When the letters are in the same horizontal line or vertical row take the letters directly below as fi for DE. If not take the opposite corners of the parallelogram taking the one on the same horizontal to correspond with the letter as sr for TA. The message as sent is fisrqtyzwgkyqlabqaqtgcdqhniqbahccwmkcbuzwdenhcbqnczuikzr. This can be decoded even if I have made several errors.

HOWARD A. BORDEN,
Lieutenant, Corps of Engineers.

Some Experiments and Notes on Photographic Reducers

FIXATION is, in certain conditions, quicker with ammonium compounds than with those containing sodium or potassium. Though ammonium thiosulphate is not such a good solvent for silver bromide as sodium thiosulphate (hypo), yet in weak solution it is a much more rapid fixer. At a strength of about 33 per cent the two fixers act at equal rates. At higher strengths hypo is much quicker in action, but at lower strength it is much slower, a 10 per cent solution of hypo taking just four times as long as a 10 per cent solution of ammonium thiosulphate. The only adequate explanation of this apparently anomalous result is that the weaker solvent diffuses much more rapidly into the film, and this tends to suggest that quicker diffusion may very possibly affect the result given by reducers containing ammonium compounds. Some experiments have now been made to see what effect the substitution of ammonium for potassium thiosulphate has in Farmer's reducer, and also the effect of the reverse substitution in the case of persulphate. In connection with this subject Dr. Scheffer once claimed that a reducer worked more nearly proportionally the greater the ratio of its speed of diffusion to its speed of solution, which theory tends to encourage the idea that a difference should be perceptible. I used solutions containing 10 per cent of the thiosulphate compound and one tenth per cent of ferricyanide, solutions of such strength being well under control and not tending to cut out the lower tones too rapidly. Two graduated negative slips were treated, the one in which most effect was produced being taken out of the reducer in five minutes, while the other was left until the lower tones appeared to be equally reduced. As the result, the slips matched almost exactly, not only in the lower tones but in all the rest. There was no visible difference anywhere, and therefore I did not think it necessary to measure either of them. Quite contrary to what might be expected, the hypo-formula proved to be the quicker in action, requiring only half the time. This effect may have been due to slight temperature variation, but the ammonium thiosulphate reducer more rapidly decomposed, and this was the most probable cause of the retarded action. As regards graduation, there was no difference whatever, hence it appears that rate of diffusion does not affect the result at all, so far as these weak solutions are concerned. Ammonium thiosulphate therefore has no advantages, which is perhaps just as well, seeing that it is a highly unsatisfactory compound to deal with.

Similar tests were then made with ammonium and potassium persulphate. These again gave negative results as regards the effect on gradation, but showed that in other respects the potassium salt has many advantages. The first tests were made with crystalline ammonium persulphate, which played a trick to which it is much addicted and refused to act at all, even when sulphuric acid was added. The sample was not a very old one, but was slightly moist owing to partial deliquescence. It crackled furiously on being added to water, but this effect is evidently no test for efficiency. After using up a considerable quantity to no purpose, I had to fall back on "tabloid" ammonium persulphate, which, with a drop of acid, worked quite normally. The two chief defects of ammonium persulphate are its deliquescence and its annoying habit of occasionally failing to work at all. In the course of years I must have thrown away a good many ounces of useless crystalline ammonium persulphate, and others have no doubt had the same wasteful experience. Potassium persulphate is not deliquescent, and so far has given me no trouble whatever. It is an extremely fine powder, and, on that account, a little difficult to dissolve, but this is a small matter easily dealt with in a "crushmeter," or in any way that will serve to break up the little balls of powder and air that form in the solution. It costs about a third more than ammonium persulphate, but is usable in much weaker solution, and is altogether cheaper and more economical. A trace of acid seems to be necessary to induce the solution to begin reduction in a reasonable time, but once it has begun to work it can be used over and over again until exhausted. I find a one per cent solution quite strong enough for general use, but am not at present able to say how long the solution will keep in either the fresh or used condition. In connection with the use of persulphate there is a point that I have not hitherto seen mentioned. A fresh unused solution is often very slow in its first attack upon the image, whereas a used but not seriously exhausted solution sets to work fairly quickly. From the chemistry of the action of persulphate, so far as it is known, it seems that the reducing action proper, which depends to some extent upon action with gelatine, does not start until the reducer contains a little silver in solution. The delay in the first attack is then due to lack of dissolved silver, and a used solution acts more rapidly, presumably because it already contains traces of silver. A fresh solution might therefore be got into good working condition by the simple expedient of allowing it to act upon a piece of a waste negative, and possibly a very small piece will serve. The uncertain time required for the first attack upon a negative is the main reason why persulphate so often spoils a good negative. No one can be sure whether the time will be a minute or half an hour, at any rate with the ammonium salt, and therefore the action often starts just when the operator is not looking, and it has gone too far before he discovers it. A used solution generally gets to work in about the same time, and delay usually indicates merely that it is exhausted. As regards the superiority of the potassium salt, there seems to be no room for doubt, and why the ammonium salt has hitherto been the only one used I am quite unable to imagine.—*C. Welborne Piper, in the British Journal of Photography.*

Photo-Micrography for the Amateur*

A New Method That Is Simple and Inexpensive

By Arthur Palme

For the past year there has appeared in the photographic press a number of articles, scientific and otherwise, dealing with photo-micrography. This subject is sufficiently attractive to make it extremely popular. With our eyes we are able to see all the beauties and wonders of the world, the "macro-world" I would say, and if our optical sense is especially pleased, we make a permanent record of the image by photography. Gaze once through a microscope and you enter a second world of wonders. These wonders are of such variety that the "micro-world" compares favorably with the "macro-world." Just as in direct, visible nature, animal, floral, and mineral objects, an endless variety of surprises worthy of record will pass your eyes.

Many an advanced amateur may have had the desire to enter the new branch of photography, but probably in all cases there was the same drawback: the necessity of an expensive microscope together with an equipment beyond the reach of his pocketbook. A suitable microscope and an optical bench will easily cost $150.

In the description following I will show a simple, and apparently hitherto unused method, which will enable every amateur to obtain with a negligible outlay photo-micrographs of any desired magnification.

The following experiment will describe in simple terms the principle of this new scheme of magnification.

Draw on a piece of white cardboard a square of say ¼ inch a side. Place the camera on a tripod, ten feet from the little square, and focus it on the ground glass. If you measure the length of a side of that square, being sharp on the ground glass, you will find it to be perhaps ⅛ inch, depending on the focal length of the camera lens. Now, approach the camera successively toward the cardboard, accommodating the focus, and you will soon find a position of the camera where the square on the ground glass appears full size; in this special case the distance of the object from the lens will be equal to the distance of the ground glass from the lens and equal to twice the focal length of the lens. If you continue to approach the square to the lens, you will notice that the image on the ground glass becomes larger than the original, but you will not be able to rack out the lens far enough to get it in focus. Therefore, illuminate the little drawing strongly, remove the ground glass from the camera, move it backwards and try to catch the image (in a dark room) on the remote ground glass; having the object (square) only a few inches from the lens. It will be necessary to hold the ground glass several feet away from the lens, and you will see a square of several inches side length on it. The hyperbolic curve in Fig. 1 shows for a lens of 5 inches focus the magnifications at different distances of the object from the lens. This is the principle; now for the practical application.

Place inside of a wooden box of convenient size a 150 watt nitrogen-filled matted tungsten lamp (90 cents), and provide in the side in front of the lamp a circular opening of about 3 inches diameter. Close this opening with a common reading glass (bi-convex lens) of 3½ inches diameter (75 cents), and move the lamp inside the box a distance from the reading glass until you get a short cone of light from the box. Remove the ground glass from the camera, place the latter on a tripod, and throw the point of the cone of light exactly on the middle of the lens. The light box and the camera may stand at one end of a large room, and you will then see on the opposite wall a large, brilliant circle; move the camera sideways until it is in perfect alignment. This is easily found to be the position where the circle on the wall is free of all color. Any transparent object brought within a few inches of the front of your camera will be thrown on the wall many times enlarged, careful focusing being necessary. See Fig. 2.

Carrying glasses or slides, covering glasses, and some Canada balsam such as is used in microscopic work will be found convenient for holding small objects for magnification.

Most of the objects will be transparent. If, however, opaque preparates must be magnified, as, for example, surfaces of metals or minerals, the arrangement must be slightly changed as is plainly shown in Fig. 3.

It will be seen that the whole arrangement is simplicity in itself; no microscope, optical bench, or long bellows being required. For this reason two rooms are needed for photographic records of the image in order to exclude stray light. In one room place the projecting apparatus, cover the door between the two rooms with a light-tight curtain, in which a small opening is provided, just large enough to allow the passage of the image: an old door with a hole in the middle panel will be found very convenient.

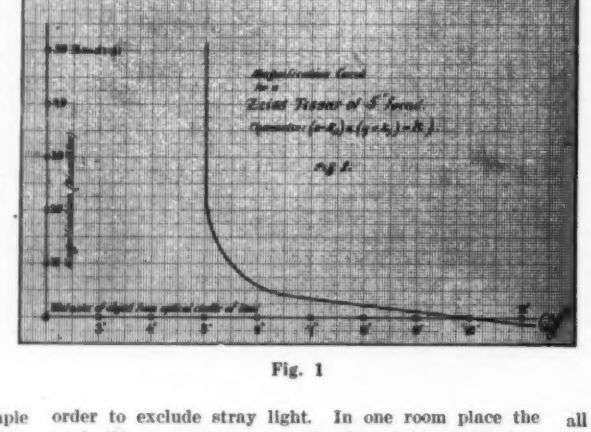


Fig. 1

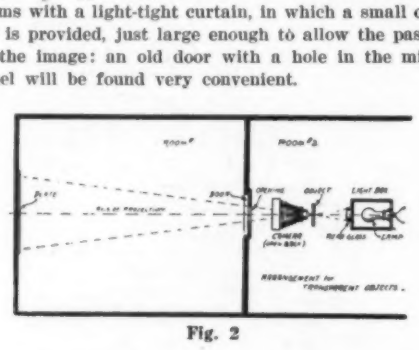


Fig. 2

To make a photographic record, turn on the light in the box, focus *very carefully*, insert a ruby glass somewhere in the path of the rays and have an assistant in the other room hold a photographic plate against the wall where the red image appears. Then expose by

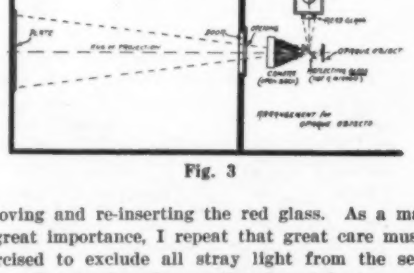


Fig. 3

removing and re-inserting the red glass. As a matter of great importance, I repeat that great care must be exercised to exclude all stray light from the second room. Cut in the aforementioned curtain an opening a trifle larger than the image on that place, and hold

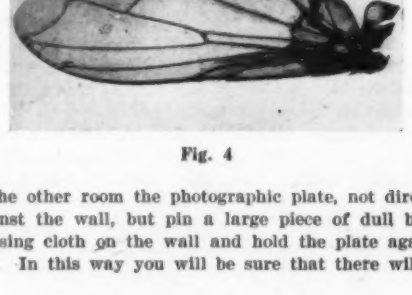


Fig. 4

in the other room the photographic plate, not directly against the wall, but pin a large piece of dull black focusing cloth on the wall and hold the plate against this. In this way you will be sure that there will be no light reflected from the more or less light-colored wall, which invariably results in a heavy fogging of the emulsion.

Slow plates (Process) may be used and strips of same, cut off with a glazier's diamond, should be used as test strips. The right exposure depends on so many factors that it is impossible to give any exact figures. The data given with the photo-micrographs accompanying this article will give an appropriate idea of the exposure under different circumstances. The original size of the object and the magnification of it determines the necessary sizes of plates to be used; 4 x 5, 5 x 7 and 8 x 10 inch plates will be needed quite frequently; 10 x 12 inch Imperial Process plates have been used for the photos of this article.

For amateurs having an enlarging outfit, it is cheaper to make a negative of small size not less than 4 x 5 and enlarge same to the desired final size; a ten-diameter magnification and a successive four-times enlargement naturally gives a total magnification of forty diameters.

Finally, it may be mentioned that such a photo-micrographic outfit should be installed in a very quiet room, as the slightest vibralion causes a severe movement of the strongly magnified image on the wall. A slamming door or the passing of a near-by trolley car may ruin a picture. Late hours, when all is quiet in and around the house, are the proper times for the amateur photo-micrographer.

I should be pleased to give any reader who intends to enter this more than interesting field any further information that he may desire on this subject.

Data for the four photo-micrographs:[1]

Fig. 4.—*Wing of a house fly:* magnification 36 diameters, on a 10 x 12 Process plate, 2 seconds' exposure with an arc light of 1,000 watts and a Zeiss Tessar *f*:4.5 closed down to *f*:22, distance from the arc to the wall 20 feet.

Fig. 5.—*Embryo of a chicken:* (Preparate made by Miss M. A. Carson) 36 diameters, 10 x 12 plate, 3½ seconds' exposure, arc light, *f*:22, 20 feet distant. This interesting picture shows the cross section of the little red knot in the middle of an egg after being thirty-six hours in an incubator. This knot was soaked in melted paraffin, hardened and cut open with a microtome; a colored thin slice was placed on a slide and magnified.

Fig. 6.—*Wing of a moth:* magnification 25½ diameters, 10 x 12 plate, 200 watt nitrogen-filled lamp, 15 seconds' exposure, *f*:4.5, 14 feet distant. Note the beautiful texture of the wing.

Fig. 7.—*Torn edge of thin paper:* magnification 25½ diameters, 8 x 10 plate, 200 watt lamp, 20 seconds' exposure, *f*:4.5, 14 feet distant.

Concluding, I would say that this method of magnification would be ideally suitable for schools and lecturers as it is superior to a microscope, which permits only a subjective observation.

*Courtesy of *American Photography*.

[1]The photos have been considerably reduced to make cuts for this article, and therefore the magnifications given do not apply for these pictures as the readers see them, but only for the original prints as submitted to the editor.

Decrease in Number of Live Stock in France

THE result of a census of live stock existing in France on July 1st last has just been published by the Minister of Agriculture. From this it appears that on that date the total number of animals of various kinds was as follows:

	Head.
Horses	2,227,209
Mules	152,266
Asses	332,244
Cattle (bovine)	12,281,849
Sheep	13,483,189
Pigs	5,490,736
Goats	469,487
Total	34,436,980

As compared with a census taken 18 months ago, these figures show a falling-off of 31 per cent, or nearly one-third, in the number of horses. No census since 1840 has shown such low figures.

Luminescence Measurements*

By N. E. Dorsey, Bureau of Standards

ALTHOUGH the excitation of phosphorescence by the radiations from radioactive substances was early observed, it appears that no quantitative measurements of the luminosity thus produced were published until 1910. In that year Marsden[1] published a series of observations which showed that the luminescence of certain materials (zinc sulphide, willemite, and barium platinocyanide) hermetically sealed in tubes containing radium emanation decreased much more rapidly than the emanation decayed, and that the rate of decrease increased with the amount of emanation initially present. He reported only relative values. At the same time Rutherford[2] advanced a theory to account for these phenomena, and showed that it agrees with Marsden's observations, within the limits of experimental error.

No later measurements of such luminosities have apparently been published, although the subject is one of considerable scientific interest. Latterly the subject has become of much practical importance, owing to an increasing use of self-luminous preparations containing radioactive excitants. Besides being used for the illumination of watch dials, push buttons, etc., these preparations have a wide field of usefulness in war appliances.

In the study and testing of these preparations we are confronted with the problem of measuring surface luminosities of small areas of various sizes and shapes. Also, it is desirable that the apparatus employed be simple in construction and use, and that the results obtained be readily interpretable in terms of photometric standards.

As the luminosities frequently are low, photometers of the usual types would be unsuited to the work even if their use did not necessitate a determination of the effective size of the preparation under study. With preparations of sufficient brilliance the spectrophotometer will give the most detailed information; but this instrument is not suitable for the measurement of the total luminosity or for the comparison of such luminosities when they differ in color.

Other apparatus or methods that have come to our attention, such as those employed by Wood,[3] Nichols and Merritt,[4] Zeller,[5] and Andrews,[6] all appear to be in some measure ill-adapted to the present problem. The apparatus described by Andrews is the simplest, but we believe that the interpretation of its readings in terms of photometric standards will be difficult.

In preparation for the study of self-luminous materials at the Bureau of Standards, a photometer has been devised which is exceedingly simple in construction and use, and appears to be well suited to much of this work. By the use of standardized lamps and screens the results obtained by its use can be interpreted readily in terms of photometric standards.

In its simplest form, this photometer consists of a box two or three meters long and twenty-five or thirty centimeters square. A light carriage carrying a 1.5 or two-candle electric lamp runs on ways extending the entire length of the box, the filament being in the center of the section of the box. By means of two cords attached to the carriage, one passing over a pulley at the rear end of the box, the distance of the carriage from the end of the box can be adjusted as desired. The position of the lamp is determined by a graduated steel tape having one end attached to the carriage. Both ends of the box are closed, but in the front end is set a milk-glass window, two or three centimeters square, backed by a color filter so chosen as to make the transmitted light match in color the luminescent light that is to be measured. In the bottom of the front end of the box there are suitable openings through which pass the cords for operating the carriage, the steel tape, and the leads carrying the current to the lamp. The entire interior of the box, including the ways and the lamp carriage, is painted a dead black, and movable black diaphragms and screens must be so placed as to screen the milk-glass window from all light scattered from the walls of the box. All joints must be light tight, and the openings through which the cords, etc., pass must be suitably screened or provided with black cloth hoods to prevent the passage of light. It is desirable that the top of the box be hinged, so as to facilitate the adjustment of the diaphragms and lamp.

The photometer is used in a darkened room. As the luminosities with which we are concerned are often quite faint, any stray light, such as may leak under a door, becomes very annoying and should be carefully excluded. In the lamp circuit are placed a suitable ammeter and adjusting rheostats. Unless there is a second observer whose sole duty it is to keep the current at the proper value, the current should be supplied by a storage battery being used at the time by no one else.

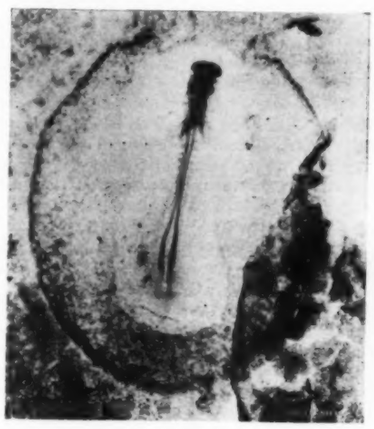


Fig. 5

Fig. 6

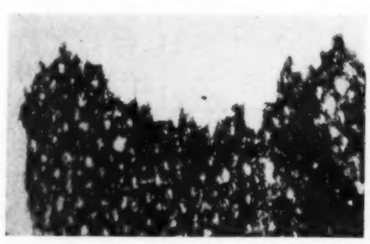


Fig. 7

In order to make a measurement, the luminous material, applied to a card or enclosed in a thin walled glass tube[7] of small diameter, may be placed directly against the milk-glass screen and the position of the lamp is then adjusted by the cords until the luminosity of the milk-glass appears to be the same as that of the material. The observer's line of sight should be perpendicular to the milk-glass. If the color match is good the tube will almost disappear when the adjustment is correct. The luminosity of the material is inversely proportional to the square of the distance of the lamp from the milk-glass screen, the constant of proportionality being determined from a careful photometric standardization of the lamp and of the screen and color filter as used. For example, the photometer screen and a certain specimen were found to be of equal brightness when the lamp was 70.5 centimeters from the screen. The lamp was a tungsten lamp burning at the color of a 4 wpc carbon lamp and had a candle-power of 1.38 in the direction of the length of the photometer. For the light from such a source the surface brightness of the screen used had been found to be 3.96 microlamberts per meter-candle illumination from the rear. Consequently, this specimen had a surface brightness of $3.96 \times 1.38 \div (0.705)^2 = 11.0$ microlamberts. A microlambert is the brightness of a perfectly diffusing and completely reflecting white surface when illuminated by a source of unit candle-power placed at a distance of ten meters.

When greater precision is desired, the top of the milk-glass window should lie in the central section of the end of the photometer and be so placed that the vessel containing the material under study can be placed immediately above it and so that the luminescent surface lies in the plane of the window. For the highest precision it is desirable that the material be contained in a thin vertical vessel with sides of thin plane glass and bottom of thin material, so that the two luminous fields can be brought as nearly as possible into contact, so as to secure a minimum visibility for the line of separation.

In addition to the well known errors of ordinary photometry, others of prime importance have to be guarded against. For low luminosities it is necessary that the eye of the observer be in a highly sensitive state; this condition is not attained until after he has been in total darkness for at least fifteen or twenty minutes. In order to retain this sensitive state the illumination used for reading the scale, recording the observations, or other purposes must be as faint as is consistent with the work, and must be continued only as long as is absolutely necessary. Furthermore, this light must be of such a nature that it will not affect the luminosity of the material under study. These conditions may be practically attained by the use of a small pocket flashlight suitably screened and provided with a ruby bulb.

In order that the luminosity of the preparation shall be due solely to the radioactive excitant, it is necessary that the preparation shall have been excluded from all light except its own for at least several hours before the measurement is made. During the measurements the milk-glass window must in every case be screened from all light coming from the preparation; otherwise a false setting will be obtained. The error due to this cause may easily amount to over 10 per cent in the luminosity.

Another error that must be carefully guarded against at these luminosities is that due to the "Purkinje effect." By this is meant the fact that two adjoining luminous surfaces of different colors that appear to be of equal brightness when viewed from a certain distance will not appear to be of equal brightness when viewed from a different distance. This means that when we are dealing with different colors our judgment of equality of brightness is a function of the intensity of the illumination. This effect becomes very pronounced at low intensities. A further difficulty is introduced by the fact that under such conditions the judgment of equality of brightness depends upon the peculiarities of the eye of the observer; different observers judge differently. On account of both these reasons it is important that the illuminated milk-glass be a very close color match to the material being measured. This is true even when the luminosity is so low that it produces practically no color sensation, properly so called. Under such conditions the color match must be determined by spectroscopic examination; indeed this is the best procedure in all cases.

By the addition of a phosphoroscope and a constant source of illumination this photometer can be readily adapted to the study of the intensity of the luminescence excited by light, especially when the spectrum of the luminescence is a single broad band. If the luminescence consists of a number of narrow bands scattered throughout the visible spectrum an exact color match will in general be impossible, and difficulty may then arise from the Purkinje effect.

*Journal of the Washington Academy of Sciences. A contribution from the Bureau of Standards.

[1] *Proceedings* Royal Society, *83:* 548-561. 1910.

[2] *Proceedings* Royal Society, *83:* 561-572. 1910.

[3] Wood, R. W., *Phil. Mag.*, (6) *21:* 209-313. 1910.

[4] Nichols, E. L., and Merritt, E., *Phys. Rev.*, *33:* 37-54. 1906. *32:* 38-53. 1911.

[5] Zeller, C. A., *Phys. Rev.*, *31:* 367-375. 1910.

[6] Andrews, W. S., *Gen. Elec. Rev.*, *19:* 892-893. 1916.

[7] The tube should be painted black over two thirds of its circumference, so as to screen the milk-glass from the light given out by the material. The unpainted side is turned toward the observer and the tube is rotated so as to reduce the visible dark line on one side to the smallest amount consistent with a screening of the milk-glass.

Electrical Treatment of the Wounded*

Recent Methods Developed During the War

By W. J. Turrell, M.A., M.D. Oxon., Major, R.A.M.C. (T.)

THE treatment of wounded soldiers by electrical methods appears to have been first systematically practiced by the French in 1907 during the Morocco War. Two very interesting articles dealing with this subject have appeared in the French medical papers. One of these, entitled "The Physiotherapy Department of the Military Hospital at Dey in Algeria," by Dr. Hirtz, appeared in the *Archives d'Electricité Médicale*, March 10th, 1913; the other, entitled "The Physiotherapy of Those Wounded in War," by M. Miramond de Laroquette, was read before the Congress of the French Academy for the Advancement of Science held at Tunis in 1913.

It is interesting to note that Dr. Hirtz holds strong views on the importance of the independent control of physiotherapy departments. "The department of physiotherapy," he says, "forms a division self-governing in the same way as a department of medicine or of surgery. It was only by degrees that we obtained this independence, and we attach great importance to it. It is only under such conditions that good and exact work can be done. Each department is thus rendered responsible for its own work." The physiotherapy department comprised a subdivision for electrotherapy, one for radiology, and one for mechanotherapy. The number of patients treated during the year 1913 amounted to 323. Dr. Hirtz remarks that, as is usually the case, the greater part of these, that is 236, fell to the lot of the electrotherapy department. The cases treated by electrotherapy included articular rheumatism, acute or subacute, neuralgia, neuritis, paralysis, functional troubles caused by wounds, synovitis, arthritis, and hydrarthrosis. The 236 cases required 12,543 individual séances. The cases treated by radiotherapy included cervical adenitis, arthritis, certain maladies of nervous origin, and superficial tumors. Chronic effusions into joints were treated by pastile doses of X-rays once a fortnight. The success of the department led to the f rmation of similar establishments in all the large French military hospitals. Both the above writers claim that without the aid of physiotherapy the number of those permanently disabled and in receipt of State pensions would have been much increased.

The fully equipped electro-therapeutic department at the Radcliffe Infirmary, Oxford, opened in November, 1913, was in full working order at the outbreak of war. We were therefore able to avail ourselves of its services on the arrival of the early convoys at the 3rd Southern General Hospital, of which hospital the Radcliffe Infirmary forms a section. It will probably facilitate discussion if I give a brief outline of the electrical methods adopted in our department.

As regards results it is, of course, absurd to compare those obtained at the physiotherapy departments at base hospitals, which are regarded by some unenlightened medical officers as the dumping ground for all obstinate or incurable cases, with the results obtained at command depots, to which only those cases likely to be fit for foreign service within six weeks are usually sent. We rely a good deal on ionization. Except when treating wounds or mucous membranes we do not attach any importance to the specific action of any special solution, but invariably use a two per cent solution of common salt. We make use of large pads, strong currents, and séances of as long duration as the time of the department will permit. Cases treated in this way include subacute and chronic rheumatism, some cases of neuritis, impestigo, sycosis, septic and indolent wounds, stiff joints, etc. Where the limitation of movement in a stiff joint is due to fibrous bands or adhesions ionization is often very useful; in these cases massage and manipulation should be performed as soon as possible after the conclusion of the electrical séance. Where the stiffness of a joint is merely due to cold and rigidly contracted muscles, immersion of the limb in hot water for twenty minutes at a temperature of 115 deg. Fahr. will probably be all the treatment preparatory to massage that is required. If expense and space are of no consideration the water may be kept continually agitated by spouting jets (the *eau courante* system) or by a motor-driven propeller (the whirlpool bath system), and thus the molecules of water, cooled by radiation to the limb, are constantly replaced by hotter molecules. The consideration of this refinement, however, more properly belongs to another section.

The treatment of indolent wounds and ulcers by zinc ionization gives excellent results; after about two or three treatments by this method I now change to ultraviolet radiation from the tungsten arc and obtain more rapid healing. The ionic medication of foul, extensive, and sloughing wounds with the chlorin ion quickly allays the odor and leads to rapid healing with smooth flexible scars and free movement in the surrounding tissues. I believe that this class of case is far too rarely sent to the electrical department for treatment.

In addition to the electrical department I have charge of sixty surgical beds; I have, therefore, had an opportunity of trying this method on early cases. The first case I treated in this manner was a patient with a gunshot wound of the forearm, received at the range of only one or two yards. Selous, the big game hunter, has, I am told, pointed out that a bullet striking a limb at a very short range has a similar effect to that of an explosive bullet. Anyhow, this man had a small bullet wound over the intercosseous space about the middle of the extensor surface of the forearm, and nearly the whole of the skin and superficial tissues on the flexor surface of the forearm were replaced by a foul, sloughing, very offensive mass; there was no fracture and no nerve lesion. The wound was treated the day after admission by chlorin ionization; in twenty-four hours all offensive odor had ceased, and in two or three days the wound was quite clean, and, I think, in six or seven weeks the patient was discharged to light duty with the wound healed, a very flexible scar, and perfect movement in wrist, hand and fingers. Probably many have had equally successful results with this treatment, and I do not bring this case forward solely to show the success attending this method, but because of an unaccountable rise of temperature which suddenly occurred about the sixth day with no symptoms and no physical signs, the wound remaining perfectly healthy in appearance. The temperature reached to about 105 deg. Fahr., and subsided in two or three days. This case occurred early in the war. I have had another very similar case with a higher range of temperature, reaching to 106 deg. Fahr. This was also a wound of the forearm similar to the one I have described, but not quite so extensive nor so foul. It was similarly treated, and there was nothing in the wound or its neighborhood to account for the pyrexia. A blood culture gave a negative result. I shall be extremely interested to hear if any have experienced these alarming rises of temperature in the treatment by ionization of extensive superficial and sloughing wounds. I have not experienced any similar rises of temperature when treating deep suppurating wounds and sinuses, however septic they might be.

Many superficial wounds in my wards have been treated by hypertonic solution, but neither in theory can I see that the osmotic pressure of these concentrated solutions can be so effective as the ionic exchange excited by the application of the galvanic current, nor have I found in practice the use of hypertonic in any respect as effective as ionic medication. Hypertonic solutions are certainly more easily and readily applied than ionic medication, and therefore have a large sphere of usefulness in the treatment of septic wounds.

Recently we have been trying Dakin's tubes with Dakin's solution in the treatment of deep cavities associated with bone lesions and necrosis, and have obtained good results by this method. The treatment, however, seems to require a special kind of wound if the best results are to be obtained. The ideal wound is a deep sulcus in which the fluid may collect, with no sinus leading off and no counter-opening. The sinuses are apt to develop an air or pus block and so prevent the permeation of the fluid. Ionic medication is more penetrating in its effect and is not so affected by these local conditions.

Nerve injuries, contusion, concussion, compression and section, partial or complete, form a large proportion of the cases that are sent to the department for treatment. If the nerve reacts to the faradic current we utilize a rhythmically reversed faradism from a coil of low coefficiency, and in this we follow the generally recognized practice. When there is no reaction to faradic stimulation there is not the same consensus of opinion in regard to the choice of treatment; some prefer condenser stimuli, some the sinusoidal current, and other rhythmically reversed galvanism. Of these the last mentioned is the simplest and cheapest; it is, moreover, quite painless and very efficient. We are told that when a nerve is severed or otherwise rendered functionless the muscles which it supplies hang flaccid, like hammocks from their attachments; waste and toxic products accumulate within their substances; fatty degeneration takes place; and, finally, if untreated, conversion more or less complete into fibrous tissue occurs; so that by the time the nerve has regenerated the muscle has lost all contractile power. Our object in treatment is therefore to maintain the nutrition and contractility of the muscle while the nerve is undergoing the process of regeneration. The sudden sharp contraction elicited by the rhythmically reversed galvanic current seems to me the ideal one for the removal of these waste and toxic products and for the maintenance of the muscular tone. We follow out the technique advocated by Bergonié for the treatment of infantile paralysis, and feel satisfied that we are in good company in following the lead of a teacher to whom electro-therapists owe so much. This treatment is so simple in its application, the apparatus needed is so inexpensive, and the results obtained are so good that it is deplorable that it is not more generally adopted at the smaller hospitals and convalescent homes. We have all seen limbs permanently disabled by neglect or inefficient electrical treatment, the function of which could have been more or less completely restored if the proper methods have been followed. At nearly all hospitals and convalescent homes, however small, there is usually some form of apparatus for the supply of the continuous current, and only the addition of a clockwork metronome, costing about £2, together with a little instruction and occasional supervision of those in charge, in needed to insure the recovery of many cases which, if neglected, will become a permanent charge upon the State.

I do not intend to deal with the subject of muscle and nerve-testing beyond laying stress upon the importance of associating the examination of the voluntary movements and sensation with the electrical reactions. Although we are all ready to admit the importance of this in theory, in practice we are apt to neglect it, unless we methodically associate them. In order to coördinate these observations, and to keep a record of them, we make use of a card. (The card was exhibited.) Bergonié's apparatus for the production of electrically provoked exercises we find most useful in restoring the tone of muscles wasted from disuse or slight nerve disturbance. We have recently been extensively using it with great success for the development of the quadriceps extensor after surgical removal of the semilunar cartilage.

Electrotherapy, like other methods of treatment, has usually failed in most cases of severe shell shock; many of these cases have very marked electrophobia, and electrical treatment then tends to aggravate their symptoms. There is, however, one class of nerve shock in which the Bergonié treatment generally results in a speedy cure. These are the cases which are under the fixed impression that they have lost all power in their lower limbs, and are unable to walk or even to stand up. One or two vigorous séances on the Bergonié chair are usually sufficient to convince them that there is still some contractile power in their muscles, and they are then soon able to stand and walk without assistance.

The chief indication for the use of diathermy in the treatment of the wounded is the existence of severe pain; unfortunately this is an indication which frequently arises. The hyperæmic changes induced in the tissues by the passage of the diathermic current are of great value in the treatment of conditions where the local nutrition is at fault. The high rate of oscillation of the electrons in the tissues excites tissue drainage as well as producing frictional heat. It has several times been pointed out how completely and efficiently diathermy fulfills the indications for treatment in trench feet, relieving the pain when all other means have failed, reducing the stasis and congestion of the parts by tissue drainage, and diminishing to a minimum the loss of tissue. The results claimed for diathermy in this treatment have now been confirmed by many workers.

*A paper read before the Section of Electro Therapeutics of the Royal Society of Medicine on Nov. 17, 1916. From a report in *The Lancet*.

Volkmann's ischæmic contracture exhibits symptoms which seem to indicate the application of diathermy. I have treated three such cases by this method. Two were very advanced when they came under my care, and were not in the least benefitted. The other was an early case and the progress of the disease was arrested, and very marked improvement took place.

Two interesting cases of local tetanus have shown marked symptomatic improvement under the influence of diathermy. One of these was sent to me by Major A. F. Hurst to have his reactions taken. The muscles of the left shoulder were rigidly contracted, exhibiting an almost incredible degree of stony hardness. To take the electrical reactions of muscles in such a condition was clearly an impossibility. The patient had previously taken an anæsthetic very badly, so I decided to try the effect of diathermy. The application of this current resulted in a degree of relaxation far greater than that obtained from any other application, and even slightly greater than that obtained some days later from complete anæsthesia. The relaxation lasted for some hours and rendered the taking of the reactions quite a simple matter.

The other case occurred in the muscles of an officer's leg. Diathermy was regularly applied, and definite relief was experienced after each treatment. I received recently the following letter from this officer, in which he very clearly describes his symptoms and the effect of the treatment:

"15/11/16.

"Dear Major Turrell: I have been meaning to write to you for some time, as I knew you would be interested to hear how I am getting on. Your letter has just been received, and I am only too happy to give you any information I can with regard to my leg.

"I was wounded in the left leg on October 13th, 1915, by H. E. shell, and arrived at Oxford on the 22nd. There was no operation, as the surgeon in charge did not consider it advisable to remove the pieces of shell; my leg seemed to be getting better and after about a month I was able to hobble round with sticks. My foot at this time used to swell a great deal toward night, and the foot seemed then to gradually stiffen up with violent pains at intervals; this gradually spread up the whole leg to about the knee, and I was compelled to take to my bed again. The pain at times was very bad, similar to a very bad attack of cramps, and then my leg became rigid and stiff, and at other times used to get horrible jumps and it was impossible to keep it still, and whenever the doctor or nurse looked at it, used to stiffen up at once. The night seemed to be the worst, and consequently I got very little sleep. I often had to get up in the middle of the night on crutches to try and obtain relief, my leg was so cramped and sore. It was about this time that you first visited me and prescribed a course of electric treatment for my leg, and I shall never be able to thank you enough for the relief it gave me. I cannot remember the names of the different treatments, but the first one—diathermy or heat pads—certainly relieved the pain, and after the first two or three visits to you I got immense relief. I never looked back after this, and although the progress was slow I gradually lost all pain and was able to get sleep at night. The nervous jumps slowly disappeared and my leg became gradually normal except for contraction of the tendons. I was unable to straighten my ankle or knee, and it was thought at one time that my tendo Achillis would have to be severed. Gradually the knee straightened and I was able to get my heel to the ground. I was for some time on crutches and was able to leave the hospital on February 5th, 1916, walking with sticks. . . . I am now able to walk comfortably, but am unable to flex the ankle more than at right angle to my leg. The circulation is not very good and I feel anything tight round my calf. I am still getting Boards and have not been passed fit for overseas yet."

This officer was treated by ionization on December 6th and 7th, 1915; diathermy from December 7th to 22nd, 1915, also occasionally static breeze; and ionization, chlorin ion, to relieve contraction, from December 29th, 1915, to February 4th, 1916.

Of course, the treatment of such cases by diathermy is purely symptomatic, and in no way replaces the need for antitoxic serum or other specific treatment. The treatment is, nevertheless, a very important one in these cases, both on account of the immediate relief which it affords and also on account of its tendency to prevent the permanent muscular shortening or contraction which has been found likely to result in these cases.

In relieving the pain of sciatica, neuritis, lumbago, and many like conditions diathermy is of the greatest value. In dealing with sciatica I have practically abandoned all other methods of physical treatment, early cases quickly are cured, some old-standing ones require much perseverance and patience, and occasionally one comes across a case which shows no improvement. Electrotherapy would be an uninteresting and a tame proceeding if we had all successes and no failures. The mistake which I have most often made in dealing with these obstinate cases has been in chopping and changing from one treatment to another. I believe that if sciatica will not yield to diathermy no other electrical method will benefit it, unless, perhaps, radiotherapy. As a preliminary to the passive movement of stiff joints the analgesic effect of diathermy and its influence in diminishing the spasmodic contracture of neighboring muscles are of great service.

In no other electrical modality is technique of such importance as in the application of diathermy. The chief points to pay attention to are: 1. To apply the current slowly. 2. To be careful to apply it in the right direction and over the right area. 3. To continue its application for a sufficient time—a maximum of fifteen to twenty minutes. 4. To obtain as great a heating effect as is consistent with safety. 5. To select the size of pad and electrode suitable for the extent of area to be treated.

It is quite easy to treat cases by diathermy without producing any benefit; it is also possible by correct technique to cure these cases. For instance, take that most troublesome complaint, coccydynia. By following the routine method, and placing one electrode on the abdomen and the other over the sacrum and coccyx, and giving the usual dose, probably no improvement will result. On the other hand, by adopting a more intensive method most cases can be cured. The patient lies on his abdomen, a cylindrical metal electrode is placed in the rectum, and a small pad and electrode about the size and shape of the coccyx is placed over that bone, and the current slowly administered to the toleration of the patient. I have personally cured five or six cases in this way; the last was a coccydynia in a wounded soldier following a contusion of the spine.

The high-frequency vacuum tube we find useful in some conditions of trench feet and other painful conditions; ultra-violet radiation is to some extent replacing the use of this modality in our work.

One of the most useful and indispensable forms of apparatus in the treatment of wounded soldiers is the static machine. The equipment of no electrical department is complete which does not include an efficient instrument of this kind. The unidirectional current of the static machine, with its enormously high potential and its minute amperage, can be produced by no other form of electrical apparatus; and it is the possession of these specific properties which renders it capable of producing results in certain cases which are unobtainable by any other means. We know from our condenser testing that the vigor and amplitude of a muscular contraction depend chiefly upon the voltage used. In a healthy muscle with the condenser charged at fifty volts, we get a weak muscular contraction; with a condenser of similar capacity but charged at 100 volts, a stronger contraction results; and a more vigorous contraction still is obtained from a charge at 200 volts. Now with the Morton wave-current of the static machine the muscles to which the electrode is attached require a potential of several hundred thousand volts before a discharge can take place across the seven or eight inch spark-gap, which is often used. So vigorous and of such amplitude is the resulting muscular contraction that we are enabled by this method to free muscular fibers from involvement in scar-tissue by the force of their own contraction. So readily and accurately can the force of this contraction be regulated that, by alternately widening and approximating the discharging balls, we can make use of this current as a form of electrical arthro-moteur for the movement of stiff joints in the hands and feet, and as a means of breaking down slight adhesions. This method is especially useful for breaking down the adhesions which persist in trench feet after the subsidence of the acute and painful symptoms. In the Morton wave-current these vigorous contractions alternate with periods of complete relaxation, and thus by a form of automuscular massage the stasis and congestion of recent sprains are removed, and the return of mobility and function is often hastened by several days or weeks. In the same manner, with suitable technique, the re-absorption of the fluid in synovitis of the knee-joint can be rapidly promoted. A full understanding of the *modus operandi* of this modality is necessary to enable us to appreciate in what a large number of cases, resulting from wounds and exposure, it is applicable. There is no form of electrical or other apparatus by the use of which quicker or more permanent results can be obtained. I hope that we shall presently hear Capt. Humphris's remarks on this treatment, for on account of his much longer experience he is able to speak with far more authority on these matters than I am.

I have so recently read a paper on the ultra-violet radiation before this section that I do not propose to detain you with any remarks of mine on this subject, but we shall be very pleased to hear the experience of others with this treatment.

To summarize very briefly, the war services which electrotherapy can render to the State are as follows:

1. A considerable number of those who would otherwise remain permanently unfit can be rendered fit for general military service.

2. The severe pain of many of those wounded or injured by exposure on military service can be completely arrested or greatly relieved by these methods.

3. Electrical treatment is of great service in many of the less serious cases, often effecting a speedy cure and a quicker return to the fighting line.

4. Electrotherapy, fully and efficiently developed, will result in a very considerable reduction in the amount paid for State pensions, and, what is far more important, will restore function to many crippled limbs.

The last point we have to consider is the personnel of the staff of the electrical department, and this, though perhaps the most important point of all, I must deal with very briefly. A great deal of the electrical treatment administered at many of the convalescent homes and smaller hospitals serves no other purpose than to bring the treatment into disrepute. One frequently sees as I saw to-day, a patient with complete reaction of degeneration of the musculospiral nerve who had been treated in a perfunctory manner for five weeks with the faradic brush, with no other result, of course, than to destroy completely the patient's faith in all electrical methods. Under the present system with about two months' training and the possession of a small faradic battery anyone can become a so-called medical electrician, and practice as an expert the most specialized of all the medical sciences. I think that this condition of things could be largely remedied by appointing properly qualified electrotherapists to supervise and instruct in electrical methods in the different hospitals and convalescent homes in their area. Of course, the more important treatments, such as diathermy and the static, would have to be conducted at properly organized and equipped departments. But, nevertheless, under proper supervision and control an amount of work invaluable to the patients and the State could be performed in the auxiliary hospitals by means of ionization and rhythmically reversed galvanism.

These suggestions are made in no carping spirit, but with a full recognition of the very valuable services which are being rendered by only partially trained nurses and masseuses, and they are made with an earnest desire to increase the usefulness of these ladies and to extend the benefits of efficient electrotherapy to regions which they have not yet reached. This section cannot fail to feel otherwise than much gratified at the development which has occurred in electrotherapy during this war and at the increased recognition which it is daily receiving.

Weight of Steel in New War Vessels

THE Bureau of Construction and Repair of the Navy Department has prepared a statement showing the approximate weight of steel material in each type of vessel appropriated for in the measure. The officials of the bureau state that at present it is not practicable to divide the tonnage into plates, sheets, angles, etc. The statement is as follows:

Type	Steel Per Vessel, Tons	Total Steel of Each Type, Tons
4 Battleships	13,761	55,044
4 Battle cruisers	15,025	60,100
4 Scouts	2,997	11,988
20 Destroyers	325	6,500
1 Fuel ship	3,300	3,300
1 Hospital ship	4,000	4,000
1 Ammunition ship	4,000	4,000
1 Gunboat	548.5	548.5
30 Submarines	186.6	5,598

The Insulating Properties of Asbestos

T. SCHOPPER, in the *Chem.-Zeit.*, says that commercial asbestos contaminated with iron compounds may be purified by treatment with a 2 per cent aqueous solution of oxalic acid for 48 hours, followed by washing with water; the strength of the asbestos is not affected. A band of asbestos, 20 millimeters wide, showed at 14 different places an electrical resistance of 600-700 ohms; after treatment as described, the resistance increased to 1,500,000 ohms. An alternative method consists in heating the asbestos for 20-24 hours in a current of hydrogen or carbon monoxide at 390-400 deg. Cent., and then washing with very dilute hydrochloric or sulphuric acid and afterwards with water.

Methods for Preserving Bread

For French Prisoners in Germany

FRENCH bread is famous the world over, and it is not surprising to learn that France leads the great European nations in consumption of bread. A table recently published by M. Lucien Lévi, Laboratory Chief of the *Conservatoire National des Arts et Métiers*, gives the following figures per capita per year for the consumption of grain:

France	246 kilogrammes
England	165 kilogrammes
Italy	125 kilogrammes
Austria-Hungary	116 kilogrammes
Germany	79 kilogrammes
Russia	56 kilogrammes

Reduced to terms of bread the figures for France come to 600 grammes per capita per day. These 600 grammes when ingested furnish 1,500 calories, or 46 per cent of the average adult's daily requirements. In Germany, as the table shows, only a third of this quantity of bread is consumed, but in spite of this restriction Germany produces only a part of what her populace requires, averaging 37,000,000 quintals yield of grain, but consuming over 48,000,000, so that she has been obliged to import 11,000,000 quintals. Hence the British blockade has forced her to manufacture the war bread which has a lowered proportion of flour and a percentage of starch. This bread is said to be "dark brown, heavy, pasty and indigestible." Hence it was not long before French prisoners in German camps began appealing to the home folks for some of the good French bread they were accustomed to. The response was so generous that the French Government has finally been impelled to take the matter in hand to insure the bread arriving in good condition and without undue delay. The result of their agitation of the matter has been a genuine discovery of a sealed package warranted to keep bread fresh not merely for a few days, but for several months—a discovery, moreover, which is neither secret nor patented and may well prove a boon to American housewives who do their own baking. Mr. Lévi thus describes the process in a late number of *La Nature:*

The important question of bread for prisoners of war is how to contrive that bread which spends at least three or four weeks in reaching its destination in the German camps shall arrive in a suitable state of conservation. At present fresh bread contains not less than 36 to 37 per cent of water. (Before the war the average percentage of moisture in the whitest flours made was about 34.)

This proportion of water is evidently the principal cause of alteration in bread kept for a certain time. Humidity is, in fact, the enemy of bread, as of most alimentary products. Its action resides mainly in the fact that it favors the development of the spores of *mucedinea* or molds such as *penicillium glaucum* and *oïdium aurantiacum* which are deposited on the surface of the bread. Hence there is obviously less risk of deterioration in dry, warm weather than in cool, damp periods. If the bread dries as it ages the microbe action is retarded and the bread remains longer intact; if on the contrary it retains its normal humidity, or if this is augmented, the bread molds.

Many bakers prepared breads of different mixtures and different degrees of baking, but without success, being in ignorance of the real cause of decay.

Science in reality affords but two methods of solving the problem:

1.—Manufacture dry products, analogous to biscuit or the war biscuit prepared for the military staff, and to the *biscottes* or toasted bread sold for jaded stomachs. This is the system which the Government seems to have stopped at, for the present. . . . These products, because of their hardness, cannot be consumed as soon as they arrive in Germany; they must first be moistened in order to soften them. Even so they are better than the famous KK bread of our enemies . . . but cannot truly replace the normal bread our men are used to.

2.—Manufacture, with the aid of normal bread, of a sort of temporary conserve, the bread being somewhat stale, to be sure, when eaten, but still tender, since it has preserved the greater part of its humidity. This is the process advised by M. Fleurent, professor in the *Conservatoire National des Arts et Métiers*, a description of which and of its practical results were communicated to the Academy of Sciences in two notes dated July 19, 1915, and July 31, 1916. This process is of extreme simplicity. . . . The dough is prepared in the ordinary manner. For the fermentation (I. e., "rising") it is placed in pans of oblong shape, and when ready to be baked the surface should be smooth and free from cracks. Each loaf should weigh not more than 1 kilogramme (2.2 pounds). The baking should be rather prolonged, the better to insure perfect sterilization. The loaf thus obtained can be packaged with facility. On leaving the oven, each loaf, while still hot, is wrapped in two sheets of stout paper, closed at opposite ends, and then tied up. All wrapping papers of firm texture are suitable, those of light color being obviously preferable. When the oven has cooled to a temperature of from 120 to 130 deg. Cent., the packages are replaced in it and maintained at the same heat for fifteen or twenty minutes. They are then taken out and allowed to cool, after which they are ready for immediate dispatch. In this way a sort of hasty conserve is prepared, whose envelope itself has been sterilized by heating, and bars the return of mold germs, though preserving a desirable humidity of 28 per cent. Loaves thus treated have been kept a month or more in a dark, damp cellar without being altered, of as good flavor as ordinary stale bread.

More than 50,000 loaves made by different bakers have been sent to Germany and received with delight. The paper generally used is a light yellow paper made of a mixture of ground wood and cellulose with ordinary starch sizing. After baking it has a pleasant odor, due to formation of caramel. It is probable that the formation of this caramel is accompanied by the production of traces of formic aldehyde, which favors sterilization and conservation.

The same process has been applied with equal success to other confections, containing eggs and fatty substances, and hence of higher alimentary value. This is the first time that paper has been called on to play a *rôle* analogous to that demanded of metal food containers, and the present experiment gives reason to hope it may have a more general application in certain

Use of Molybdenum in Stellite

SMALL percentages of molybdenum are used in certain patented non-ferrous alloys consisting essentially of chromium and cobalt. These alloys are known under the trade name of "Stellite," and possess remarkable high-speed qualities when used for machine tools. They are also employed for cold chisels, wood-working tools, cutlery, etc. Their use in cutlery is of particular interest as they do not tarnish under atmospheric influences and are unaffected by fruit acids.

In so far as molybdenum is concerned, two stellite alloys are of interest, namely, those containing cobalt, chromium, and molybdenum, and those containing cobalt, chromium, tungsten, and molybdenum. Haynes,[1] the inventor of these alloys, says:

"When molybdenum is added to a 15 per cent cobalt-chromium alloy [15 per cent chromium], the alloy rapidly hardens as the molybdenum content increases, until the content of the latter metal reaches 40 per cent, when the alloy becomes exceedingly hard and brittle. It cuts keenly and deeply into glass, and scratches quartz crystal with ease. It takes a beautiful polish, which it retains under all conditions, and on account of its extreme hardness its surface is not readily scratched. When 25 per cent of molybdenum is added to a 15 per cent chromium alloy, a fine-grained metal results, which scratches glass somewhat readily, and takes a strong, keen edge. Its color and luster are magnificent, and it will doubtless find a wide application for fine, hard cutlery. It can not be forged, but casts readily, and its melting point is not abnormally high."

Analysis of a typical molybdenum stellite.[2]

Constituent.	Per cent.
Mo	22.50
Co	59.50
Cr	10.77
Fe	3.11
Mn	2.04
C	0.87
Si	0.77
S	0.084
P	0.040
W	0.00
Ni	0.00
	99.684

These stellite alloys are silvery-white. They are insoluble in nitric acid and are only slowly attacked by hydrochloric acid. Following is the analysis of a typical molybdenum stellite:

—*Bulletin No. 111, Bureau of Mines.*

[1] Haynes, Elwood, Alloys of cobalt with chromium and other metals: *Transactions* Am. Inst. Min. Eng., vol. 44, 1912, pages 576-577.

[2] Hibbard, H. D., Manufacture and uses of alloy steels: Bulletin 100, Bureau of Mines, 1915, page 61.

Use of Molybdenum in Chemicals

THE chief use of molybdenum in chemicals is as ammonium molybdate, $(NH_4)_2MoO_4$, and sodium molybdate, Na_2MoO_4. The first is employed principally as a reagent in the quantitative determination of phosphorus in iron and steel, various ores, fertilizers, etc., and in the quantitative determination of lead. The equivalent of several tons of metallic molybdenum is said to be consumed annually in this form by the iron and steel plants in the United States for the determination of the phosphorus content of their products. It is reported that ammonium molybdate is also used for fireproofing, and as a disinfectant for cloth used in railroad coaches and for similar purposes. It is said to be a strong germicide. Sodium molybdate was at one time used rather extensively in ceramics to impart a blue color to pottery and in the manufacture of certain glazes, but it is understood to have been replaced almost wholly in this field by cobalt compounds. It is also used in dyeing silks and woolens. Molybdenum trioxide, Mo_2O_3, is used for coloring rubber and is said to be non-injurious to the material.[1]

A Correction

IN the article on "Anomalies in the Animal World" that appeared in the issue of the SCIENTIFIC AMERICAN SUPPLEMENT for February 10, No. 2145 the author's initials appeared as B. W. Shufeldt. Probably most of our readers recognized the error, and understood that it should have read Dr. R. W. Shufeldt, but it seems proper to make a record of the mistake.

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